EPIDEMICS

CONSIDERED WITH RELATION TO

THEIR COMMON NATURE, AND TO CLIMATE AND CIVILIZATION.

IN

TWO LECTURES

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PREFACE.

THESE Lectures are published at the request of some who formed part of the distinguished audience to which they were addressed. A few details in the second lecture are retained which were omitted in the delivery that it might not exceed the prescribed time. It will be a sincere satisfaction to the author if this publication should in any degree reawaken and extend an interest in the very important subject of which it treats.

10 PALL MALL EAST,
January 1856.

LECTURE I.

ON THE COMMON NATURE

OF

EPIDEMICS.

Ladies and Gentlemen,

I am this evening to give you some account of Epidemic Diseases. I am to endeavour to explain their nature, and I am to consider them with a special reference to Climate and Civilization.

The exposition of such a subject to such an audience is a character of the present time, and an honourable one. It includes topics which it has been the custom to consider purely professional. It would seem at first view but little fitted for popular illustration.

But it is one privilege of our day that the great treasury of knowledge gradually opens wider and wider. Some of the most precious stores accumulated there, long thought to be the exclusive property of a privileged few, it is now admitted belong equally to the many. Among these are the results which modern science has developed relative to the class of subjects which is about to engage our attention.

There is now a conviction that some account of the structure and functions of the human frame, of the action of physical agents on this wonderful machinery, and of the principles which relate to Individual, as well as to Public Health, ought to form a part of elemental education. There is, too, a growing conviction that the necessity for such knowledge is not

restricted to the physician; that it is essential also to the educator, the mother, the nurse, and indeed to every one who would enjoy, together with the due development of his physical, intellectual, and moral nature, the full term of the boon of life.

It is also to be considered that the main causes which shorten and embitter human life, as far as that unhappy result depends on the disturbance of health, are within our own control. There is the closest connection between the knowledge we have acquired of the physical conditions on which the life and health of individuals and communities depend, and on our command over those conditions. Every fact we have learnt respecting the great laws of nature, on our conformity to which our very existence depends, has taught us that the circumstances which produce excessive sickness and early death are preventable.

The character of Pestilence which gave it its great power and terror—that it walketh in darkness,—is its character no longer. Its veil has fallen, and with it its strength. A clear and steady light now marks its course from its commencement to its end; and that light places in equally broad and strong relief its antagonist and conqueror—CLEANLINESS.

I invite you then to a consideration of the facts and views now to be presented, in the hope that the information will give you a just apprehension of a subject which intimately concerns the well-being and the safety of every one, and in the further hope that it will stimulate and enable you to take part in one of the great reforms of our day, the advancement of which all may help but none can stop.

The term Epidemic has become a popular one. It is derived from two Greek words, which signify "upon the people—prevalent among the people"—diseases which, at one and the same time, prevail extensively among large masses of the people.

Recently these diseases have received another name, which is also becoming familiar—"Zymotic," from a Greek word,

which signifies to "ferment," as if the efficient cause of these diseases, whatever it may be, acts in the manner of a ferment.

Epidemic diseases, though called by a common name, present great differences in their external characters. Plague, Yellow Fever, Cholera, Small-Pox, Typhus, Scarlet Fever, Influenza, present characters so definite and special, that they have been naturally regarded as distinct diseases, and they really are so different as to render it desirable, for many reasons, that each should be discriminated and denoted by its proper name. Amidst this great diversity in form, however, they present very striking resemblances, of which the following are generally recognised :—

1. Epidemics resemble each other in being all fevers. They all exhibit that particular assemblage of symptoms which from time immemorial it has been agreed to denote by the term Fever.

This is as true of the great Epidemics of former times as of those which prevail in our own.

The so-called Black Death of the 14th century was a fever —an aggravated form of the Oriental or Bubo-Plague ; in which there occurred, in addition to the ordinary symptoms of that dreadful disease, effusions of black blood, forming black spots on the arms, face, and chest. From this circumstance it derived its name. These effusions on the external surface of the body were accompanied by profuse and mortal discharges from the internal organs.

The Oriental Plague, the great devastator of Europe in former times, and still the scourge of some portions of it, is a fever characterized by specific glandular inflammation.

The Sweating Sickness of the 15th and 16th centuries was a fever, with symptoms of acute rheumatism, attended with a fœtid perspiration which poured from the body in streams. "Suddenly," says Hollingshed, "a deadly burning sweat assailed their bodies and distempered their blood, and all, as soon as the sweat took them, yielded the ghost."

The Cholera of modern times is a fever, which appears in its

true character when the first stroke of the disease does not prove fatal, and time is allowed for the full development of its successive stages.

The common Epidemics of the day—Ordinary as distinguished from Extraordinary Epidemics—typhus, scarlet fever, small-pox, measles,—are so universally recognised as fevers that the popular notion of fever is derived from the external, characters which these maladies present.

2. Epidemics resemble each other in the extent of their range. Ordinary diseases attack single individuals, and if, from season or other causes, several cases occur simultaneously, they are still isolated and scattered. They never prevail at the same time among several members of a family, or among the inhabitants generally of a court, street, or town. Epidemics, on the contrary, as I have just said, derive their name from their attacking large numbers at once.

The great Epidemics of all ages have been strikingly characterized by their wide spread course. The Black Death extended from China to Greenland, and desolated in its course Asia, Europe, and Africa.

The Bubo-Plague of the middle ages often extended beyond its proper seat. In the 15th century it spread seventeen times over different European countries, and extended to the most distant northern nations.

The Sweating Sickness prevailed simultaneously or in rapid succession over England, France, Germany, Prussia, Poland, Russia, Norway, and Sweden. "It extended," say the chronicles of the day, "like a violent conflagration which spread in all directions; yet the flames did not issue from one focus, but rose up everywhere as if self-ignited."

The Influenza of the middle ages took a range which may be said to have been universal. In our own day we have seen the same disease attack almost every family, in nearly every city, town, and village; spread within a short period over the whole of Europe, and then extend through the vast continent of the New World.

Cholera traverses the earth in zones, spreads with equal facility through tropical and polar regions, and attacks alike the seats of civilization, and the huts of the slave and the savage.

3. Epidemics resemble each other in the rapidity of their course. Sometimes, indeed, they begin slowly, advance haltingly, and gather strength in silence. For some time they give so little indication of their power that the apprehension of their presence is very constantly regarded as a "false alarm." Now and then, here and there, they strike a sudden and mortal blow; but it is only an individual that falls. After a considerable interval, perhaps at a great distance, another blow is struck; and then one by one, another and another, until at last the fact becomes too manifest to be doubted or denied, that two victims have been seized in one family—several in the same street—three or four on the same day, in distant parts of the town, or in the adjoining town, or it may be in towns separated from each other by the distance of hundreds of miles. At length the terror-stricken nation, startled from its fondly cherished security, sees no place safe from the Plague. When, however, the causes are intense, it may break forth quite suddenly, and spread with astonishing rapidity.

In 1831, when Cholera first appeared in Cairo, it extended within the space of five days over the whole of Lower Egypt, desolating simultaneously all the towns and villages of the Delta.

In 1832 it leaped at one bound from London to Paris, and when once there, spread in five days over thirty-five out of forty-eight quarters of the city.

When Influenza broke out in London in 1847, it spread in one day over every part of the metropolis, and upwards of 500,000 persons suffered from the malady.

Many who now hear me must retain a lively recollection of the rapidity with which it pervaded this city, and seized on almost every one, high and low.

4. Epidemics resemble each other in giving distinct and unmistakeable warnings of their approach. These warnings

consist of two events: first, the sudden outbreak and general spread of some milder epidemic; and, secondly, the transformation of ordinary diseases into diseases of a new type, more or less resembling the character of the extraordinary disease at hand.

It is a very singular fact that both in the middle ages, and in modern times, the lesser Epidemic which has generally preceded and pre-announced the coming of the greater, is Influenza.

The history of European Epidemics from the 14th century downwards, shows that whenever a new Plague was at hand, destined to become truly European, it was preceded by a sudden outbreak of Influenza, as general as it was violent. This is exemplified with singular uniformity in the Epidemics of the 16th century—the severest epidemic period on record. It is most remarkable that in our own day the first visitation of Epidemic Cholera was preceded by an outbreak of Influenza which resembled, in the most minute particulars, the violent and universal Influenza that ushered in the mortal Sweating Sickness Epidemic of 1517.

So again, on the second visitation of Cholera, in 1848, it was preceded, as we have just seen, by the universal Influenza of 1847.

The second circumstance, and a most instructive one it is, premonitory of the advent of a great Epidemic, is a general transformation of the type of ordinary diseases into the characteristic type of the approaching pestilence. Sydenham gives a graphic description of such a transformation in the character of the fevers and inflammatory diseases prevailing in London some months before the outbreak of the Great Plague. He states that this change consisted in an approximation, in several striking features, of the general type of disease, to the distinguishing characters of the Pestilence which had not yet appeared, but was close at hand.

In 1831, in the wards of the London Fever Hospital, I observed and recorded a precisely similar change in the general

type of the fevers in London, six months before the first visitation of Cholera. Anterior to that period, fever in London, for a long series of years, had been essentially an acute, inflammatory disease, for which blood-letting, and other depleting remedies were indispensable. At this period it ceased to be an inflammatory disease; it became a disease of debility, in which no one could think of bleeding; and so closely did the prevailing fever now put on the general character of the approaching plague, which was as yet six months distant, that the fever into which those Cholera patients fell, who were not killed by the first stroke—the consecutive fever, as it was afterwards called—could not be distinguished from the primary fever in the wards of the Hospital when Cholera was at its height, which had appeared there for the first time six months previously, and which has never disappeared since.

It is further very remarkable that the Professors of Veterinary Medicine and Surgery in London noted at the same time a similar change in the type of the diseases of the lower animals—horses, cows, sheep, and all domestic creatures;—a change requiring a similar modification of the remedies which they had been in the habit of using.

5. A further character of great Epidemics, partly arising from the last, is this:—they are actually present and in operation some time before they assume their distinct and proper form. Sometimes, indeed, the very first cases are most intense and characteristic, but at others they are scarcely to be distinguished from the severer attacks of ordinary disease of a like nature. Hence doubt is sometimes reasonably entertained of their true character. When at length increasing numbers leave no doubt of the actual presence of the dreaded malady, the first announcement of it is always received with incredulity and sometimes with resentment; and so it is that Epidemics always take a country by surprise—burst suddenly on an unprepared people, who wilfully shut their eyes against the plainest evidence, as if they would avert the event by denying its existence.

6. Again, Epidemics resemble each other in the uniformity of their course. They present, with great regularity, periods of comparative quiescence and activity — periods of well-marked increase, culmination, and decrease.

7. They further resemble each other in the manner of their migration. They advance by leaps. On breaking out in a locality they soon come to their height, decline, and disappear. Then they attack another locality; here they pass through precisely the same process as before, and proceed to a third, fourth, or fifth district, and so on. Sometimes indeed they localize themselves on the same spot for a considerable period, and then several places may be simultaneously affected; but for the most part a large city may be regarded as a cluster of towns, through the several districts of which epidemics advance as if they were proceeding from one town or village to another. Hence the duration of an epidemic in a place is generally proportionate to its size. The several localities attacked being visited in succession, a space of time is required to spread through the whole of them proportionate to the magnitude of the town.

8. Epidemics resemble each other in the periodicity of their return.

On its first visitation (1485) the Sweating Sickness spread over the whole of England in the course of one year, when it disappeared.

After an interval of twenty years it broke out a second time quite suddenly (1505); revisited nearly all the seats of its former ravages, and again disappeared at the end of six months.

On its third visitation (1517), after an interval of eleven years, it again finished its course within six months.

Its fourth visitation (1528) was repeated after a further interval of precisely eleven years. Such was its violence on this occasion, that the historians of that day designate this period by the significant name of the "Great Mortality." It drove Henry VIII. from London, destroyed several of the

most distinguished persons of the Court, impressed the nation, from the monarch to the peasant, with an awful feeling of the uncertainty of life, continued its destructive course for its accustomed period of six months, and then again disappeared.

From this to its fifth and last visitation, twenty-three years elapsed (from 1528 to 1551.) It then broke out with unmitigated fury, spread once more over the whole of England, ceased within six months, and from that period has never reappeared in any country.

The Oriental Plague of the middle ages returned with a like periodicity; and so it does at the present day in the countries in which it maintains its ancient reign. It recurs with much regularity about every ten years.

The Fever Epidemics of the metropolis return pretty constantly about every ten or twelve years.

The Irish Typhus Epidemics have recurred nearly decennially for the last 150 years.

Epidemic Cholera, on its first visitation, ravaged Great Britain for a period of fifteen months. It then wholly ceased; after an interval of sixteen years it again broke out, and pursued its former course for the same exact period of fifteen months, and then ceased.

Within the brief interval of only five years, it last year accomplished its third visitation. It now protracted its stay for a period of seventeen months; coming sooner and staying longer.

9. Again, Epidemics resemble each other in the brevity of the space that intervenes between the attack and death.

The Black Death was often fatal on the first day of the attack—generally on the third or fourth. In England it was sometimes fatal within twelve hours, and frequently in two days, particularly when spitting of blood or any other form of hæmorrhage was amongst the early symptoms.

The violent inflammatory fever which characterized the Sweating Sickness, generally ran its course in a few hours; in

severe cases, indeed, the crisis was always over within a day and night, but it often proved fatal in six hours.

In our own day we have witnessed many instances in which Epidemic Cholera was fatal within twelve hours. I have known several in which the fatal event followed in ten hours, the patient having been within an hour of the dreaded attack in *apparent* health.

In all great epidemics the protraction of the disease beyond three or four days is a favourable omen. One of the objects in the treatment of the sick is to gain time. If Nature's first violent effort to expel the enemy that has taken possession of the system, does not destroy life, the vital powers rally, and the frame often survives the storm.

10. Lastly, Epidemics resemble each other in being produced by the same causes. The whole tenor of experience shows that whatever produces an especial liability to one epidemic, produces a similar liability to every other.

The Causes of epidemics, as of all other diseases, are divided into two classes,—the predisposing and the primary. The predisposing causes are those circumstances which bring the body into a fit state for the action of the primary. The primary cause is the agent which directly and immediately excites the disease.

If a number of persons, in an ordinary state of health, say a hundred, are exposed to the primary cause of any epidemic—to the poison of Cholera for example—probably not more than ten would be seized with the disease. Why do the ninety escape? The poison, by the supposition, encompasses and acts upon all alike: why do ten only suffer? Suppose these same hundred persons took a large dose of arsenic, or an overdose of chloroform, not only would not one in ten escape, but every individual would certainly perish.

It is conceived that the primary cause cannot take effect unless the system be in a state of susceptibility to its action; that there is in the body an innate power of resistance to all noxious agents of this kind, rendering it, when in full vigour,

invulnerable to them; that there are certain circumstances which weaken, or destroy this resisting power, and which even impart to the body a peculiar susceptibility to the influence of such agents—and these circumstances are called predisposing causes.

The predisposing causes of epidemics may be divided into two classes—External and Internal. The external are those which vitiate the atmosphere; the internal are those which more immediately vitiate the blood.

The vitiators of the atmosphere include overcrowding, filth, putrescent animal and vegetable matters of all kinds, exhalations from foul cesspools, sewers, rivers, canals, ditches, marshes, swamps, &c. Causes of this class are also called *localizing*, because they favour the generation and spread of epidemics in the localities in which they abound.

The causes which more immediately act from within are those which either directly introduce pernicious matters into the interior of the body, in the shape of foul water or putrescent food; or which indirectly accumulate noxious matters within the system, by impairing the action of the excretory or depurating organs whose office it is to maintain the blood in a state of purity, by removing out of the system substances which having served their purpose have become useless and pernicious.

The earnest attention which has been recently directed to the first class of causes has led to an advancement in the science of prevention, the importance of which it is impossible to over-estimate.

Your time will allow me to give only one illustration of the action of a predisposing cause. I select as my example, *Overcrowding*.

The Statistical Society of London some time ago appointed a Committee of its Council to make a house-to-house examination of the parish of Marylebone, with a view to ascertain how many families in the parish occupied a single room as a living and sleeping room. In the course of this inquiry, one

of the examiners came to a house in which there was one remarkable room. It was occupied not by one family only, but by five. A separate family ate, drank, and slept in each of the four corners of this room; a fifth occupied the centre.

"But how can you exist," said the visitor to a poor woman whom he found in the room, (the other inmates being absent on their several avocations), "how can you possibly exist?"

"Oh, indeed, your honour," she replied, "we did very well until the gentleman in the middle took in a lodger."

I see every day in the wards of the Fever Hospital the consequence of taking in such lodgers. An epidemic shows it not more truly, but more strikingly.

Within the walls of an establishment for pauper children at Tooting, there were crowded 1395 children. Little more than one hundred cubic feet of breathing space was allowed for each child, 500 being the smallest compatible with safety. One night Cholera attacked sixty-four of these children; 300 were attacked in all. Within a week 180 perished.

In the Workhouse of Taunton there were 276 inmates. In some of the rooms the breathing space was not more than sixty-eight cubic feet. Cholera swept away 60 of these inhabitants in less than a week.

In the County Jail of this same town, the breathing space allowed to each prisoner ranges from 819 to 935 cubic feet. Not a single case of cholera, nor even of diarrhœa, occurred among the prisoners in this jail.

The town's people also escaped, while in the overcrowded workhouse, 22 per cent. of the total number of the inhabitants were swept away.

In the village of East Farleigh, near Maidstone, 1000 persons were assembled for hop-picking. They were lodged in sheds, and had about eighty cubic feet for breathing space: in a few days diarrhœa became universal among them; ninety-seven were attacked with cholera, and forty-six died. In the same village, at the same time, under another employer who had provided proper accommodation for his labourers, there was a complete immunity from the epidemic.

I could add cases of the like kind without number. I could show that animals are affected by this cause of disease no less than men; that horses overcrowded in stables die of glanders; dogs in overcrowded kennels die of distemper; sheep overcrowded in ships, even during a short passage from one country to another, die in great numbers of febrile diseases: results which prove the operation of a general law of nature. I could adduce, did the time permit, equally decisive examples of the action of each of the principal external predisposing causes just enumerated.

It has been often said that we cannot tell the difference between the air of the mountain side and that of the crowded hospitals and fever nests of towns. If it were so, it would be sufficient to say, Life is a more delicate test than Chemistry. But it is not so. The impurities in these pernicious places can be detected by chemical analysis, and examined as readily as the constituents of the atmosphere itself.

The moisture in the air of a crowded room may be condensed by ice. It condenses indeed spontaneously on the walls and windows, and on all surfaces, and may be collected in sufficient quantity for examination and experiment.

If a portion of this deposit be put on a piece of platinum and burnt, a strong odour of organic substance is given off, and a quantity of charcoal remains. If the deposit be allowed to stand for a few days, it forms a solid, thick, glutinous mass, having a strong odour of animal matter. If examined by a microscope, it is seen to undergo a remarkable change. First of all, it is converted into a vegetable growth, and this is followed by the production of multitudes of animalcules,—a decisive proof that it must contain organic matter, otherwise it could not nourish organic beings.*

At every expiration the lungs pour a portion of organic matter into the surrounding atmosphere; at every moment

* See the interesting experiments of Dr. Angus Smith, on the Air and Water of Towns, "Report of the British Association for the advancement of Science," p. 16 *et seq.*

the skin does the same. This matter is the dead portion of the body, which it is one of the special offices of these depurating organs to remove out of the living system as useless and pernicious.

It is indeed pernicious, for it is an animal poison, more concentrated in this than in any other form of excrementitious matter, since in other exertions the noxious particles, in their transmission out of the body, are diluted with other substances, but as they issue from the lungs and skin, they are in a great degree undiluted. Ventilation and cleanliness prevent this matter from accumulating, and render it innoxious. But it collects in large quantities on the furniture and walls of dirty houses, and is the main cause of the disagreeable smell of the rooms in which it abounds. In some instances the walls are coated with it. It was so in one particular building in which, during a local epidemic outbreak, twelve persons were attacked with cholera, and four died.

From recent chemical and microscopical examinations of the air of some crowded and filthy localities in the metropolis, it appears as a general result, that decomposing organic matter is always contained in such air,—the never-failing presence of animalcules testifying its existence, and their number and size indicating its amount.

Imagine the state of the atmosphere in the dormitories of the Tooting children : in the sixty-eight cubic feet of breathing space of the inmates of the Taunton Workhouse ; in the eighty cubic feet of the Kentish hop-pickers ; in the four corners and centre of the five-family room.

Conceive the state of the atmosphere in this room at night ; all the members of the several families collected ; every breath of external air excluded ; the windows, and perhaps even the chimney, carefully fastened up. This stagnant and poisoned air, breathed over and over again by every individual for seven or eight hours continuously ; respiration, the special and admirable apparatus which nature has constructed for purifying the blood, thus made the very means of corrupting it. I have

known from two to three cases of typhus produced nightly, for a fortnight together, in a room of this description, by sleeping in it for a single night! Can we wonder at the generation of typhus in such a room in *ordinary* seasons! Can we wonder at the spread and the havoc of an epidemic in it in *epidemic* seasons?

But besides the contamination of the air by external causes, it is conceived that the atmosphere itself undergoes natural changes which predispose it to the development and spread of epidemics. From time immemorial, the popular belief has been that such changes do take place, and that they manifest themselves by unmistakeable signs.

Among such signs may be reckoned,—a disturbance of the regular and ordinary condition of the atmosphere; an inversion of the seasons—summer in winter, and winter in summer; long-continued drought succeeded by torrents of rain, causing rivers to overflow, and the seed to rot in the earth; cloud, mist, fog, favouring excessive dampness, under the influence of which spring up inordinate growths of the lower species of plants, producing mouldiness, and the blood-spots, and other coloured vegetations that adhere to houses, and household furniture, and wearing apparel, and personal ornaments, and the person itself; under which also, fostered by a steadily elevated temperature, spring into being and activity, myriads of the lower tribes of animals—locusts, caterpillars, flies, frogs, covering the face of the earth, and devouring every green thing that the deluge of rain had left; and, as the sequence of these antecedent conditions, dearth and famine, closing the long series of the year's calamities. Such, in all ages and countries, have been the recognized portents and precursors of a coming year of pestilence.

And there is truth in this.

It is quite certain that such atmospheric changes do take place, and prepare the way for pestilence. It is quite certain that there is an epidemic meteorology. This epidemic condi-

tion of the atmosphere is at length coming within the range of science. The first step towards this result, which promises to be of the highest practical value, we owe to the well-devised and patient observations of Mr. Glashier, continued through the three recent Cholera epidemics.

Among other important facts, he has determined that there is—1. An increased pressure of the atmosphere, greatest at the worst period of the epidemic.

2. An increased density of the atmosphere, not arising from an increase of watery vapour; for,

3. The quantity of water in the air was 1-20th less than the average, at the same time that the mean weight of a cubic foot of air was 2 grains above the average.

4. An unusual alternation of heat and cold, yet the heat predominating to such an extent that in particular localities it rose as much as from 2° to 8° above the average. These excesses were most striking at night, particularly in the parts of London on a level with the Thames, where the night temperatures ranged from 7°, 8°, 9°, and 10° above the temperature of the country, and even of the suburban districts. These temperatures were highest, especially the night ones, when the mortality was greatest; and the mortality was greatest where the temperatures were highest.

5. A remarkable increase above the average in the temperature of the water of the Thames. From a long series of observations it had been found that the normal temperature of the Thames is 51.7°. During the prevalence of the epidemic it rose to 60°, 66°, and once to 70°. At this temperature the "simmering" water must have poured enormous quantities of vapour into the surrounding atmosphere; not the pure vapour of water, for that cannot arise from a river which is the recipient of the foul contents of all the sewers and cesspools of the metropolis. In some instances there was an excess of 20° of the temperature of the water above that of the air. For twenty-eight continuous nights during the height of the epidemic, the average excess exceeded 16.5°.

6. An unusual prevalence of haze, mist, and fog; the fog being sometimes so dense that London could not be discerned from Greenwich.

7. An extraordinary stillness and stagnation of the air, both by day and night. Sometimes in the low-lying districts not a breath could be observed. Even when at more elevated stations the wind was moving with a force of 1lb 7oz., the pressure was only $\frac{1}{4}$lb in the heart of London.

Wind is the ventilator of nature. Artificial ventilation, as far as it is successful, is an imitation of nature's process. It is stated on undoubted authority (Maitland's History of London) that for several weeks before the Great Plague broke out in London, there was an uninterrupted calm, so that there was not sufficient motion of the air to stir a vane. Baynard, a contemporary physician, confirms this fact. The like circumstance is mentioned by Diemerbroeck in giving an account of the plague at Nimeguen. At the period when the last plague visited Vienna, there had been no wind for three months.* The terrific outbreak of the cholera at Kurrachee was preceded for some days by such a stagnation of the atmosphere that an oppression scarcely to be endured affected the whole population. It is obvious that calms must favour the accumulation and concentration of effluvia from every source from which they arise.*

8. A general deficiency in the tension of common positive electricity.

9. A deficiency of one fourth of the rain-fall for the year During 118 consecutive days there was scarcely any rain, and not a single drop for 18 days at the period of the highest mortality.

10. A total absence of ozone at all the stations near the river, while at stations of high elevation it was of general occurrence.

These observations relate particularly to the epidemic of

* See Sir Gilbert Blane's "Select Dissertations on Medical Science," p. 131.

1854, which was more carefully watched than the two former; but the results are similar for each.

"The three epidemics," says Mr. Glashier, in summing up the results of his inquiry, "were attended with a particular state of atmosphere, characterized by a prevalent mist, thin in high places, dense in low. During the height of the epidemic, in all cases, the reading of the barometer was remarkably high, the atmosphere thick; and in 1849 and 1854 the temperature above its average. A total absence of rain, and a stillness of air amounting almost to calm, accompanied the progress of the disease on each occasion. In places near the river, the night temperatures were high, with small diurnal range, with a dense torpid mist and air charged with the many impurities arising from the exhalations of the Thames, and adjoining marshes; a deficiency of electricity, and, as shown in 1854, a total absence of ozone, most probably destroyed by the decomposition of the organic matter with which the air in these situations is so strongly charged.

"In both 1849 and 1854, the first decline of the disease was marked by a decrease in the readings of the barometer, and in the temperature of the air and water; the air, which previously had for a long time continued calm, was succeeded by a strong S. W. wind, which soon dissipated the former stagnant and poisonous atmosphere."

We knew before that such influences were in operation, but they had not been weighed and measured. We now know definitely something of an epidemic atmosphere, and the information obtained is most significant; for it shows that the several meteorological changes that take place during the prevalence of an epidemic concur to produce a heavy, warm, moist and stagnant atmosphere, with disturbed electricity: conditions highly favourable to the decomposition of organic matter.

Under the influence of such an atmosphere, over the moist and warmed surface of every filthy place, over the entire mass of all accumulations of filth in streets, lanes, and courts, and

within and about houses, and over the heated surface of all foul water, decomposition goes on with the utmost activity, and the products are poured into the stagnant air.

Against such products the human body has no defence. The lungs admit whatever is brought to them—poisonous and salubrious substances alike. They are guarded by none of those protective contrivances which we see in some other parts of the body. Whatever is capable of suspension in the respired air passes with it directly into the current of the circulation, and when once there, is carried with astonishing rapidity into the very substance of the vital organs.

From the quantity of air which the lungs receive, some conception may be formed of the amount of noxious matter which may be introduced into the system through these portals.

At each inspiration there enter the lungs of an ordinary-sized person about 20 cubic inches of air. There are 20 respirations in a minute: 400 cubic inches of air must therefore enter in one minute; 14 cubic feet in one hour, and 366 cubic feet, or 36 hogsheads, in one day. To meet this the heart sends into the lungs at each contraction two ounces of blood; there are 75 pulsations in a minute, during which 150 ounces are propelled into the lungs; a quantity which gives 562 pounds in one hour and 24 hogsheads in 24 hours.

The main purpose for bringing these enormous quantities of air and blood together, with such velocity, is to provide for the enormous waste which is caused by the rapid and unceasing mutation of organic matter. The activity of an organ is sustained at the expense of the matter of which it is composed. No thought passes through the mind, but an equivalent portion of the substance of the brain is consumed; no nervous current flows along the nervous conductors, but a corresponding portion of nervous tissue is used up; no muscular movement, no glandular secretion takes place without a proportionate waste of muscle and of gland. What must be the amount of supply required to meet this waste, when able-bodied men employed in their ordinary labour lose from 2 lbs.

to 5 lbs. and upwards of their weight twice a-day.* Some physiologists of eminence have estimated that in order to supply that waste, there passes in the course of every 24 hours as much fluid through the thoracic duct† as equals the whole quantity of blood in the body.

The results of the highly interesting experiments recently made by Professor Graham on the part taken by the active agent in all these processes—organic membrane, of which the organic cell is the type, demonstrates that all the phenomena known as Endosmos and Exosmos depend on a chemical action involving the destruction of organic membrane. In this process chemical action is set up dependent upon active chemical agents, neutral substances being inoperative. Out of this chemical action a new force is induced, the *Osmotic* force; a purely chemical being converted into an equivalent mechanical force, which is made subservient to the essential phenomena of organic and animal life: a *vis motrix*, a force which is to the extra-vascular movements of the body, what the contraction of the heart is to the vascular.

In a frame so constructed, any particles contaminating the circulating fluid, most rapidly pervade and contaminate every part of the system.

It has been sometimes imagined that the quantity of matter suspended in the atmosphere and conveyed into the system in respired air, must be too minute to exert any serious influence upon the body.

One single puncture of the finger, so small as not to be visible without the aid of a lens, has introduced into the system a sufficient quantity of putrid matter to cause death with the most violent symptoms.

A few drops of the liquid matter obtained by a condensation of the air of a foul locality, introduced into the vein of a dog, is stated to have produced death with the usual phenomena of typhus fever.

* See Experiments on the daily loss of weight sustained by workmen employed in gas-works.—*Philosophy of Health, Vol. II. p.* 390 *et seq.*

† The tube which conveys the debris of the body, together with the nutritious part of the food,—both measures of change or waste.

It is certain that on the introduction into the body of an inappreciable portion of the matter of cow-pox, or of small-pox, those specific forms of fever are produced.

From these and similar facts it is inferred, that when putrescent or decomposing organic matter is introduced into the blood it acts as a poison and produces the phenomena of fever, and that all the predisposing causes of epidemics act in this way—by overcharging the blood with the products of decomposing organic matter.

Strictly speaking, however, all that we really know is this—that where certain conditions exist, epidemics break out and spread; that where those conditions do not exist, epidemics do not break out and spread; and that where those conditions did exist, but have been removed, thereupon epidemics cease to break out and spread.

We call those conditions Causes, Predisposing or Localizing Causes, but how they act, whether by accumulating decomposing organic matter in the blood, or in what other way, we have no certain knowledge.

One further fact however is ascertained, that where any one of these predisposing causes is present, epidemics break out and spread just as readily as when all are present together.

Where there is overcrowding alone, for example, epidemics break out and spread. Where there is decomposing filth alone, epidemics break out and spread; and so of the whole number. The removal of one of these causes, therefore, or the removal of two or three of them, will not suffice for safety; every one must be removed before there can be safety.

This we know; all beyond this is conjecture.

Perhaps, however, you will allow me in conclusion to add a few words as to the most probable of these conjectures.

Some who have thought on this subject believe that the preponderance of evidence justifies the conclusion that the predisposing causes may themselves become efficient causes; that instances in which they actually do so, are constantly passing before our eyes; that it is practicable to manufacture fever and even epidemic fever to any amount by placing a

population under certain known conditions; that it is practicable to prevent the outbreak of epidemics altogether by placing the population under certain other conditions; that the prevalence of the predisposing causes in particular localities, in certain intensities, is sufficient to produce local epidemic outbreaks; that the prevalence of such causes in such intensities, joined to some general conditions of the atmosphere, such as the meteorological conditions which have been enumerated, particularly those which favour the accumulation and concentration of the products of organic decomposition, are all that is required to engender wide-spread epidemics. Those who adopt this view contend that the existence of a primary cause as a distinct and separate entity is not necessary to account for the phenomena.

The more common opinion however is, that joined to the predisposing causes there must always be present a primary cause, having a distinct existence, capable of travelling from one part of the globe to another; capable of spreading over any space however extended, or of confining itself to any space however small—a district, a street, a house, a room.

It is urged that though we are unacquainted with the physical form or chemical properties of this body, this is no reason why we should not understand its force as a special agent in the production of disease, just as we know the forces of other physical bodies, though not their nature.

The existence of such a body being assumed, it is conceived that it exists not in a gaseous but in a liquid state. It is supposed that it cannot exist in a gaseous state because a gas is readily diffused and dissipated; because when organic matter is reduced to a gaseous state, it has passed from the organic into the inorganic kingdom, and there is no evidence that the elementary bodies belonging to this kingdom are capable of producing any form of fever; and because there is indubitable evidence that organic matter in a recent state of putrescence —the more recent the more potent—is capable of producing the most deadly forms of fever. From these considerations it is conjectured that the primary cause, whatever it be, is some

subtle fluid which has not wholly lost its organic composition, and that it consists of particles of extreme minuteness, capable of attaching itself to the surfaces of other bodies, and even of increasing under favourable circumstances.

It is further thought that this body is not equally diffused through the atmosphere, but is only partially distributed, and that this accounts for the local distribution of epidemics, and for their occasional absence from places which apparently present all the conditions favourable to their development.

Lastly, the opinion is gaining ground, that this body acts in the manner of a ferment. It is urged in favour of this view, that a ferment being an azotized substance in a state of putrefactive alteration, the body in question must find, in the decomposing organic compounds with which impure blood is charged, precisely the materials for taking on the fermenting process. The advocates for this view think that the term "*zymotic*" is not only the appropriate name for the whole of this class of diseases, but that it also declares an interesting fact connected with them. Whatever may be the truth with respect to these points, on which at present we have no positive knowledge, one thing is certain, that practically our concern is with the known causes,—the ascertained conditions. These are palpable, definite, and capable of complete removal and prevention.

Overcrowding, for example, we can prevent; the accumulation of filth in towns and houses we can prevent; the supply of light, air, and water, together with the several other appliances included in the all-comprehensive word CLEANLINESS, we can secure. To the extent to which it is in our power to to do this, it is in our power to prevent epidemics.

The human family have now lived together in communities more than six thousand years, yet they have not learnt to make their habitations clean. At last we are beginning to learn the lesson. When we shall have mastered it, we shall have conquered epidemics. Our duties, then, and our hopes in this respect, I shall show in my next lecture.

LECTURE II.

ON CLIMATE AND CIVILIZATION.

Ladies and Gentlemen,

Having given you some account of the general characteristics which Epidemics possess in common with each other, I am now to consider them with relation to Climate and Civilization.

The principal constituents of the atmosphere maintain their equilibrium steadily over the whole surface of the globe. There is scarcely any difference in the relative proportion of its oxygen and nitrogen in the torrid zone and in the arctic regions. Whatever influence the atmosphere may have on climate must consequently depend on something adventitious to it and not in anything forming a part of it. Possibly therefore that something may be, in some degree, under human control.

The main constituents of climate are temperature and moisture, and these are the climatic conditions that exercise the greatest influence on epidemics.

Minor but still important conditions are the nature of the soil, the proportion of land that is cleared and under cultivation, the extent of forests, lakes, and rivers, the prevailing winds, the electrical state of the atmosphere, and so on.

The temperature is highest where the sun's rays are vertical, or nearly so; where the sky is cloudless; where the day is longest; and where there is the smallest difference between the fervid noon-tide heat and the temperature of the short night.

The moisture is greatest where in addition to all the other sources of humidity there are periodical rains. In the countries subject to these rains, the entire extent of the level and low land is often covered a foot deeper with water than before the rains set in.

Elevated temperature and excessive moisture are combined in tropical countries; and they are concentrated in those parts of the tropics in which there are extensive forests having an undergrowth of luxuriant vegetation; in which the tides of the ocean penetrate deeply into the interior of the land, and mix with the waters of the rivers; and in which the rivers constantly overflow their banks and form marshes and swamps.

In tropical countries there are tracts such as these that extend in unbroken continuity hundreds of leagues. The western coast of Africa (the Bight of Benin) presents an unbroken area of upwards of 100,000 square miles, consisting of one vast alluvial and densely wooded forest, irrigated by Atlantic tides, and intersected by numerous rivers and creeks, whose muddy banks are constantly overflowed.

In describing a tropical forest, Humboldt says, "Under the bushy, deep, green verdure of trees of stupendous height and size, there reigns constantly a kind of half day-light, a sort of obscurity, of which our forests of pines, oaks, and beech trees afford no example; forming a carpet of verdure, the dark tint of which augments the splendour of the aërial light."

With this luxuriance of vegetation is combined a corresponding abundance of animal life. The earth and air teem with living creatures.

"The mould," observes the same distinguished traveller, "contains the spoils of innumerable quantities of reptiles, worms, and insects. Wherever the soil is turned up we are struck with a mass of organic substances, which by turns are developed, transformed, and decomposed. Nature in these climates appears more active, more fruitful, we might say more prodigal of life."

The air is still more alive than the land. Insects fill the lower strata of the atmosphere to the height of fifteen or twenty feet, like a condensed vapor. It is estimated that a cubic foot of air is often peopled by a million of winged insects, which contain a caustic and venomous liquid, several species being nearly two lines (1.8) long.

When two persons who have their home in these regions meet in the morning, the first questions they address to each other are, "How did you find the zaneudoes during the night?" "How are we to-day for the mosehettoes?" An ancient form of Chinese politeness, showing the ancient state of that country, was—"Have you been incommoded in the night by serpents?"

It appears that there are still inhabited places in which the Chinese compliment on the serpents might be added to that of the moschettoes.

Proportionate to this prodigality of organic life is the amount of organic decomposition, the products of which are poured into the atmosphere and suspended in the surrounding vapour and fog, to which they give a decided and often a highly offensive odour.

"On fixing our eyes on the tops of the trees," describes Humboldt, "we discovered streams of vapour wherever a solar ray penetrated and traversed the dense atmosphere, exhaling, together with the aromatic odour yielded by the flowers, the fruit, and even the wood, that peculiar odour which we perceive in autumn in foggy seasons. It might be said, that notwithstanding the elevated temperature the air cannot dissolve the quantity of water exhaled from the surface of the soil and of the vegetation."

"At the distance of several miles from the coast," says Dr. Daniell, in describing the western shores of Africa, "the peculiar odour arising from swampy exhalations and the decomposition of vegetable matter is very perceptible, and sometimes even offensive. The water also is frequently of a dusky hue, with leaves, branches, and other vegetable debris floating on the surface, brought down from the interior by innumerable narrow channels that empty their turbid streams into the open ocean."

It is under these climatic conditions that the worst forms of epidemics are engendered: the most sudden in their attack, the most rapid in their development, the most general in their prevalence, and the most mortal.

The form of the epidemic prevalent in any particular district

is dependent on the physical characters of the immediate neighbourhood. Thus intermittents prevail chiefly in marshy and swampy districts; remittents also chiefly there, though not exclusively; while in other localities other forms arise approximating to the continued type of temperate climates.

For the most part these epidemics are strictly endemic, and are confined to the particular regions in which they are engendered. They never pass the limit of the equatorial or tropical zone. Yellow Fever, one of the most common and destructive of these diseases, is still more restricted in its range, being confined within a definite line determined by temperature. It is incapable of existing where the average range of the thermometer is greater than from 76° to 86° of Fahrenheit, or where the temperature varies more than from 5° to 10° night and day. Extreme heat and moderate cold immediately stop it; nay, even the prevalence of a cold wind for a few hours only.

In other instances these epidemics pass beyond the regions in which they are produced, and sometimes extend to all the other quarters of the globe. The Black Death, the range of which we have seen, was engendered in China; the Cholera of our own day, generated in the delta of the Ganges, the great source and centre of Indian epidemics, ravaged that country long before it directed its course to Europe.

When these tropical epidemics advance into more temperate climes, they lay aside nothing of their nature; they lose but little of their power. Wherever they go they decimate the populations which they attack.

One remarkable peculiarity of some of these epidemics is that natives of the region in which they prevail are for the most part unsusceptible to them. This is true however only of particular forms of pestilence. Some of them acknowledge no acclimatization. Cholera, for example, attacks equally natives and new comers. On the other hand, yellow fever rarely attacks the natives who reside permanently within its zone. Its chief victims are strangers who have recently arrived

within its sphere, particularly the inhabitants of northern climates. The susceptibility to its influcncc appears to be strictly proportionate to the degree of northern latitude from which the stranger has arrived, and the shortness of the interval that has passed since he left the European for thc Equatorial regions.

We see something of the same kind in the wide-sprcad epidemics of our own country. During the prevalence of Cholera it was observed over and over again, that persons coming directly from the pure air of the country into the infected part of a town, were seized with the disease. The explanation is not obvious. It would seem, however, to be connected with the suddenness of the shock on the system. Priestley found, that after shutting up a mouse in a given quantity of air a considerable time, it seemed to be weak, and to be slowly dying. If at this period he put a fresh mouse into the same air, it instantly died. It seems as if the system can bear a pestiferous atmosphere better when gradually than when suddenly exposed to it.

I do not know that I can give you a more vivid picture of a tropical epidemic than that which is afforded by the outbreak of Cholera in the 86th regiment at Kurrachee in June 1846.

On this occasion the atmosphere was very peculiar,—damp, hot, stagnant, and oppressive. Not a brcath of air was stirring. A few isolated cases of cholera had occurred for somc days. The utmost alarm was excited in the minds of experienced persons, who felt certain that an epidemic was at hand. Their fears were too fully realized. On the night of the 15th, upwards of 40 men were seized with cholera in its severest form; in two days more 256 were attacked, of whom 131 were already dead.

"The floors of the hospital," says Dr. Thom, the Surgcon of the regiment, "were literally strewed with thc livid bodies of men labouring under the pangs of premature dissolution. Many were brought in with the cold and clammy damp of

death; as if sudden obstruction of every vital function had taken place, and the fountains of life had been arrested by an invisible but instantaneous shock. It was indeed a sight never to be forgotten, to behold the powerful frames of the finest men of a fine corps, who had that morning been in apparent good health, and most of them on the evening parade, as if at once stricken down, and striving, with the last efforts of gigantic strength, to resist a death-call that would not be refused."

In describing a river on the west coast of Africa, Dr. Daniell says—"When I visited it, I found two vessels moored a short distance from its mouth, one of which within the space of five months had buried two entire crews, a solitary person alone surviving. The other, which had arrived at a much later period, had been similarly deprived of one half of its men, and the remainder were in such a debilitated condition as to be incapable of undertaking any active or laborious duty. Immediately before, another vessel had sailed from this port in such a deplorable state as to be solely dependent on the aid of Kroomen to perform the voyage."

In the statistical report of Major Tulloch it is stated, that out of 1658 white troops sent out to military stations on the western coast of Africa, 1271 perished from climatic diseases; while of the 387 who remained to be sent home, 17 died on their passage; 157 were reported as incapable of further service; and 180 as qualified only for garrison service; thus leaving only 33 out of 1658 men who were fit for active service.

As we pass out of the torrid zone a remarkable change takes place in the general character of epidemics. They lose more and more of their intermittent type, and become either remittent or continued. The remittent keeps its hold over the southern part of Europe, and continually breaks out in the form of Yellow Fever. As we proceed northward out of the yellow fever zone, that disease wholly disappears, and typhus and its kindred maladies take its place; typhus commencing precisely at the point where yellow fever ends.

There is, indeed, one of the ordinary diseases of temperate climes, and only one, which appears capable of penetrating within the torrid zone, and of committing greater ravages there than in lower temperatures, and that is Small-pox. With this exception, the ordinary epidemics of temperate climates do not enter the tropics, while, on the other hand, the ordinary epidemics of the tropics every now and then decimate the temperate regions.

"In these our latitudes," says Dr. William Fergusson, "cold and fatigue, and sorrow and hunger, will generate fever anywhere; but every region, every climate, will exhibit its own form of fever. With us it is Typhus; in the warmer countries of Europe, Remittent; in the upper Mediterranean, Plague; in the Antilles and Western Africa, Yellow Fever; this last being restricted to particular localities, temperatures, and elevation. While typus fever goes out when you enter the tropics, it is there that yellow fever commences; the pure epidemic of a hot climate that cannot be transported or communicated upon any other ground. Places, not persons, constitute the rule of its existence. Places, not persons, comprehend the whole history, the etiology of the disease. Places, not persons! Let the emphatic words be dinned into the ears of the Lords of the Treasury, of Trade and Plantations, until they acquire the force of a creed, which will save them hereafter from the absurdity of enforcing a quarantine in England against an amount of solar heat, of which its climate is insusceptible. Let them further be repeated in the Schools of Medicine until the Professors become ashamed of imbuing the minds of the young with prejudice and false belief, which, should they ever visit warmer climates, may cause them to be eminently mischievous in vexing the commerce and deeply and injuriously agitating the public mind of whatever community may have received them."

The time will permit me only to add further, that climate differs not only in different countries but in different parts of the same country. The climate of the country is different

from that of the city. The climate of every city, town, and village, differs from that of every other. The temperature, the moisture, and the other meteorological conditions of different districts, nay, even of different streets in the same town, vary to such a degree as to influence materially their relative salubrity and the prevalence or absence of particular classes of disease. These local climatic conditions and their connection with prevalent diseases, have not as yet received due attention: when they shall have received it, and they will receive it, a new light will be shed on local epidemics.

I pass now to CIVILIZATION.

We have no sufficient knowledge of the state of the people and of their diseases, in any of the civilized nations of antiquity, to trace the relation between them. The authentic history of periods, comparatively near to our own time, as far as concerns the diseases of the people, goes scarcely farther back than the 14th century. The first great epidemic, to which I have so often called your attention, occurred in that century, and we have reliable evidence, both of the phenomena attending this plague and the condition of the people at that time. I assume this period therefore as my starting point.

I take a civilized community to be one in which there exist—

1. A sovereign authority.
2. Laws incorruptibly administered.
3. Physical comfort generally diffused.
4. Intellectual development and activity generally diffused.
5. Recognition of the fundamental principles of religion and morality.

Without the two first, there can be no security for life and property, both of which must be placed in absolute and unquestionable safety before a single step can be taken out of the lowest depth of barbarism. Without the two last, none of the others can be acquired. These conditions are therefore the basis of the pyramid of society.

Taking these then as the essential constituents of civilization,

and applying them as a test to Great Britain, we shall see that at the eommeneement of the 14th century England was in a state of barbarism, sinee every one of these elements was wanting, although the foundation of politieal and soeial institutions containing the germs of liberty and progress had been already laid.

Practieally, however, at that period there was no sovereign authority, for the king had no suffieient power to maintain order, to protect the rights and libertics of the people, or to defend his own throne against armed men nominally his subjeets; while the lord of every feudal castle exereised a more perfect sovereignty over his vassals than the so-ealled monarch over the nation.

Every town was a fortress, and every house in whieh it was safe to dwell a castle, the inmates of whieh, like people in a garrison, constantly held themselves prepared to resist attaek, from whieh they were never seeure. Thcy slept with arms at their side.

Marauders openly eneamped on the publie roads for the plunder of the wayfarer, whieh often ended in his murder. Few persons ventured to travel alone, and none without the reasonable apprehension that they might never return alive.

Searcely a third part of the area of the kingdom was under eultivation. The remainder eonsisted of moor, forest, and fen. Vast traets were under water during the greater part of the year, and at other times formed morasses, marshes, and swamps.

Immediately beyond the walls that eneompassed the towns were large stagnant ditches, whieh being the nearest reeeptaeles for refuse, were full of all sorts of decomposing filth.

The streets were narrow, unpaved, undrained, uneleansed, and unlighted. Thcre was no provision for the removal of the town refuse. Gutters were formed at the sides of the streets, as in Bethnal Green and the negleeted parts of all our towns at the present time, into whieh the inhabitants threw the refuse of their houses; forming in dry weather a semi-fluid mass of eorrupting animal and vegetable matter, and in rainy

weather black turbid rivulets which ultimately poured their contents into some water-course.

The houses were mean and squalid, built of wood and wattles, thatched with straw, without chimnies, the windows without glass, the floors without boards, the furniture of the rudest description; the use of linen was scarcely known: common straw formed the king's bed. "The floors," says Erasmus, writing two centuries later, "generally are made of nothing but loam, and are strewed with rushes, which being constantly put on fresh, without a removal of the old, remain lying there, in some cases for twenty years; with fish bones, broken victuals, the dregs of tankards, and impregnated with other filth underneath, from dogs and men." Contemporary writers concur in representing the offensive odour of decaying straw and rushes as universal in the houses.

There was no knowledge of the art of collecting, preserving, and storing fodder. The animals for winter food were slaughtered in autumn, and their flesh salted or smoked. It was only during three months of the year, from Midsummer to Michaelmas, that any fresh animal food, excepting game and river fish, was tasted even by the nobles of the land. The common people subsisted chiefly on salted beef, veal, and pork, the price of which was one half less than that of wheat in the time of Henry VIII.

There were no fresh vegetables. As late as the 18th century salads were sent from Holland for the table of Queen Caroline. Sir John Pringle, writing in the middle of the last century, states that his father's gardener told him that in the time of his grandfather cabbages were sold for a crown a-piece. It was not until towards the close of the 16th century (1585) that the potatoe was first brought to England, where it was limited to the garden for at least a century and a half after it had been planted by Sir Walter Raleigh in his own garden. It was first cultivated as a field crop in Scotland so recently as the year 1752.

For many centuries England remained in the condition of

country in which no more subsistence is produced than is barely sufficient for the necessities of the people. Consequently every year of scarcity became a year of famine, and such years, about one in ten, occurred for ages with great regularity, and often equalled in their terrible results the worst famines of antiquity.

In a cold climate fuel is nearly as important as food, for which indeed it is a substitute. A large portion of our daily food is used up in supporting that internal fire by which the heat of the human body in every climate, and under every variety of external temperature, is maintained at the 98th degree of Fahrenheit. The greater the loss of heat by cooling, the greater the amount of heat which the body itself must generate to maintain its temperature at this elevated point. This demand for additional heat cannot be supplied without additional quantities of food, and unless these supplies are afforded, the substance of the body itself, its very tissues and organs, are consumed; a process which cannot be continued long without exhaustion, disease, and death. The phrase "starved by cold" expresses a more literal fact than is commonly understood. Unhappily the circumstances which deprive a population of the means of counteracting cold limit also the supplies of food at their command, and the pressure of the twofold privation, want of food and want of fuel, commonly occurs at the very season when both these indispensable supports of life are most needed. Some conception may be formed of the suffering to which our ancestors were exposed from this cause, from the fact that their prejudice against the use of coal as an article of fuel was such that a law was passed rendering it a capital offence to burn it within the City, and there is a record in the Tower importing that a person was tried, convicted, and executed for this offence in the reign of Edward the First. It was not until the reign of Charles the First that there was a regular supply of coals to London.

The habits of the people increased the force of these privations. Intemperance was a national vice. Excessive carousing at home, or days and nights spent in taverns, was the usual

practice among all classes, and the physical and moral evils resulting from the custom were neither redeemed nor lessened by the epithet which these habitual convivialities appear to have conferred upon the nation of "Merrie England." Caius, indeed, one of the most celebrated physicians of the sixteenth century, couples Germany and the Netherlands with England in this common reproach. "These three nations," he says, "destroy more meats and drynkes without all order, convenient time, reason, and necessitie, than all other countries under the son, to the great annoyance of their bodies and wittes."

This condition of the country and this mode of life themselves constitute the most powerful causes of epidemics; and an extraordinary concurrence and concentration of these causes are manifested in the combination of the circumstances which have been enumerated, namely, in the malarious state of the greater part of the kingdom, in the confined space of the towns, in the deficiency and putrescency of the food, in the inadequacy of the means of protection from cold, and in the intemperance of the people. These were the true sources of the malignity and mortality of the pestilences of that age.

We have no reliable evidence of the actual mortality produced by these terrible diseases; for no physician has left such an account of the epidemics of which he was an eye-witness as enables us to determine it, and there was no Registrar-General to fill up the momentous columns included in his death-roll. We can therefore only take the statements of the time as we find them.

According to the accounts of contemporary writers, the Black Death swept away, within the space of four years, a fourth part of the population of Europe. Some towns in England are stated to have lost two-thirds of their inhabitants, and it is computed that one-half of the entire population of the country perished.

Of the Sweating Sickness, Bacon says it "destroyed infinite persons;" Stowe "a wonderful number;" and other writers reckon the deaths in the places attacked by thousands.

Similar representations are given of the ravages of the Plague, of the Petechial Fever, and even occasionally of Inter-

mittent Fever ; and the substantial correctness of these statements is confirmed by entries in parish registers still extant, which tell the story of the local outbreaks of those days with graphic and touching simplicity.*

During some of the worst of these visitations, contemporary writers concur in stating that the living were insufficient to bury the dead ; business was suspended ; the courts of law were closed ; the churches were deserted for want of a sufficient number of clergy to perform the service ; and ships were seen driving about on the ocean and drifting on shore, whose crews had perished to the last man.

We can form no adequate conception of the terror inspired by these events. We have seen alarm in our own day, but then it bordered on maniacal despair. It seemed as if the last judgment had come upon the world, and men abandoned alike their possessions and their friends. The rich gave up their treasures and laid them at the foot of the altars ; neighbour abandoned neighbour ; parents their offspring, and brothers their sisters. "If," says one of the chroniclers, "in a circle of friends any one only by a single word happened to bring the plague to mind, first one and then another of the company was seized with a tormenting anguish ; certain that they were attacked with a mortal sickness, they slunk away home, and there soon yielded up the ghost."

These fearful forms of pestilence were accompanied by moral epidemics more appalling than the physical. Of these the two following may serve as examples :—

Vast assemblages of men and women formed circles hand in hand, dancing, leaping, shouting, insensible to external impressions ; some seeing visions and spirits whose names they shrieked out ; others in epileptic convulsions with foaming at the mouth ; all continuing to make the most violent muscular exertions for hours together, until they fell to the ground in a state of exhaustion. Lookers-on were seized with an uncontrollable impulse to join in these wild revels. Peasants left

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* Appendix No. I.

their ploughs, mechanics their workshops, servants their masters, boys and girls their parents, women their domestic duties, and men their business, thus to spend days and nights; these infatuated crowds passing furiously through streets, along highways, over fields, and from town to town. This madness pervaded the least barbarous countries of Europe for upwards of two centuries, under the name of the "Dancing Mania." It was universally attributed to demoniacal possession, and its cure was attempted by exorcism. It was one expression and outlet of the violent passions of that time, imposture and profligacy playing principal parts in this strange drama.

More pernicious than this madness was the mania of cruelty, an especial manifestation of which was the ferocious persecution of the Jews, who were put to death by hundreds and thousands, under the accusation that they had poisoned the wells. At Basle a number of this nation, whose European history proves them to have been everywhere amongst the most inoffensive of people, were enclosed in a wooden building and burnt with it. At Strasburg two thousand were burnt alive. Whoever showed them compassion and endeavoured to protect them, were put upon the rack and burnt with them. In numerous instances these unhappy people, driven to despair, assembled in their own habitations, to which they set fire and consumed themselves with their families. The noble and the mean bound themselves by an oath to extirpate them from the face of the earth by fire and sword

In England this relentless cruelty took particularly the shape of burning innocent people under the name of witches; an infatuation which pervaded all classes from the highest to the lowest, affording a melancholy exemplification of the close alliance between credulity and cruelty.*

But in the midst of these terrible disorders, changes which had been in silent operation during several centuries began to produce visible results. The independent power of the nobles

* Appendix No. II.

had been suppressed; the feuds that raged between them, filling the country with disorder and bloodshed, had been put down; the supremacy of the law had been established; property and life had become more secure; industry had taken a surprising start; the practical abolition of serfdom had been to a large extent effected; and at last came the final breaking up of the feudal system in the reign of Henry VII. by the passing of the law authorizing the alienation of land.

About the middle of the fifteenth century improvements in the condition of the people, which had been gradually effected by these changes, were accelerated by a succession of events that gave an extraordinary impulse to the human mind, just aroused from the long and deep sleep of the middle ages—that dark night which was now passing away.

Among the most memorable of these was the invention of printing, which the three immortal masters of the art had now completed (1436–1442), giving untiring and undying wings to thought;—

The diffusion over the West of Europe of the remains of a former civilization, by the dispersion of the treasures of classical art, literature, and science, which before Constantinople fell into the hands of barbarians (1453) had been confined within the walls of that city;—

The cessation of the long and disastrous struggle between the East and the West, by the expulsion of the Moors from Spain (1492);—

The discovery of the New World;—

And lastly, the Reformation, that stupendous work which with giant strength burst asunder the chain which consummate skill and supreme power had spent ages in forging and riveting: that stupendous work which was not merely emancipation from spiritual bondage, but the re-communication of the long-lost spirit of religion; the noble men who achieved it being ever, even in their day of triumph, less intent on demolishing the gorgeous edifice that had held the mind enthralled, than on erecting a pure temple in which it might worship with sincerity and freedom.

The time when the foundation was laid for this intellectual and spiritual renovation was also that of the commencement of physical improvement. The towns being no longer fortresses, it became unnecessary to maintain their fortifications. Walls were thrown down; stagnant moats were filled up; broader streets were opened; more convenient houses were erected. Forests were cleared; marshes and swamps were drained; more land was brought under cultivation; more vegetable matter was produced; the art of collecting, storing, and preserving fodder was discovered. Fresh meat became the food of the people during a longer period of the year; in the course of two centuries the length of that period had doubled, and at last such food was in use the whole winter. The products of growing art and manufacture superseded the beds of straw and displaced the floors of rushes. Famines ceased. There has been no recurrence of famine in England since the middle of the 15th century (1448). The proportion of people in the enjoyment of moderate competence rapidly increased. It is computed that in the 16th century the number of small freeholders realizing a clear income of between £60 and £70 a-year amounted with their families to one-seventh of the whole population, and that the number of persons who tilled their own land was greater than the number of those who farmed the land of others.*

In the next century the care of the Public Health became a recognised and direct object of the Legislature and the Magistracy. Better regulations were enforced in the metropolis for the removal of filth, for the construction and extension of sewers, and for widening, paving, and lighting the streets. In the middle of this century the Great Fire (1666) consumed 13,000 houses and left an open space of upwards of a square mile. This opportunity of improvement was not lost. Though in rebuilding the city the same lines of streets were preserved, and the streets were still kept much too narrow, yet there was some improvement in the general plan, while the houses were built of better materials; brick was substituted for wood and

* Macaulay's History, Vol. I. Chap. III.

plaster, and the buildings were less crowded and less projecting.

The spirit of improvement thus awakened exerted itself with increased effect during the whole of the eighteenth century. Agriculture, which was now rapidly advancing, had created a demand for town refuse, the fertilizing property of which began to be perceived ; so that all manner of offensive substances were regularly carried away to the fields, to the great increase of the cleanliness of the streets. At the same time many of the narrower streets were widened, the houses were entirely taken down and rebuilt, and in this operation slate was universally substituted for thatch, and brick for timber. The pavement also, which had long been the reproach of London, was improved. Population in the meantime rapidly increased, less by the relative increase of the number of births than by the proportionate decrease of the deaths, and this notwithstanding the occasional occurrence of severe pestilence. The result of the whole was an increase in the length of life.

An increase in the length of life is an expression and a measure of the sum of comfort experienced from the whole collective circumstances that make up national prosperity. In the interval between the seventeenth and eighteenth centuries that sum grew into a highly important one. Of this the proof is positive.

It happened that in the year 1693 a loan was raised for the service of the State by the method of Tontine, and that another was contracted by the same method in the year 1790 ; the interval being almost exactly a century.

The term Tontine is derived from the name of the originator of this scheme of life annuity, the principle of which is this. The person who advances £100 is at liberty to name any life he pleases, during the existence of which he draws a certain annuity ; and as the shares of the dead nominees are distributed among the living ones, the annuity continually increases till the last survivor gets the whole income.

A comparison of the experience between two Tontines gives the exact measure of the effect produced on the duration of

life, by such changes in the social condition of the people as may have occurred in the interval between them.

The results in the present instance have been elaborately worked out by Mr. Finlaison the Government Calculator. His paper will be read with great interest.* It is a highly important contribution to our knowledge, and displays the ground on which we may rest our faith in one of the most cheering promises of modern civilization. I have placed the main facts before you in a Table which exhibits them in a simple form.†

On casting your eye over this table, you see that a person of the male sex (for you observe there is a considerable difference in the results in the two sexes), living in 1793, compared with a male living in 1690, at fifteen years of age, had gained an expectation of life of nearly ten years; at twenty years of age, nine years and a half; at twenty-five years of age, upwards of eight years; at thirty years of age, upwards of seven years, and so on.

Or the gain in the expectation of life may be stated more correctly in years and decimal fractions of a year, thus: Take for example a man at the age of 30, in 1693 his expectation of life would have been 26.665; in 1790 it would have been 33.775 years.

On a minute examination of the facts it will be seen that a portion nearly equivalent to one-fourth of the total period of existence was added to human life during that century. For it will be found that if to the sum of existence actually obtained by the nominees of the old tontine we add *one-fourth* of itself, the result is nearly the same as the existence which was really obtained by the nominees of Mr. Pitt's tontines. But that so large an increase as *one-fourth* should be wanting to produce equality, is a fact so remarkable that we must not be content with expressing it in general terms.

Referring to the Table in decimals,‡ it will be found that the total existence obtained by eight persons, that is, four of each

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* Appendix No. VII. page 62. † No. III. ‡ No. VI.

	YEARS.
sex, at the ages 80, 75, 70, and 65, in the tontine of 1693, was	56.935
To which add one-fourth of itself	14.234
The increased sum is	71.169
Whereas eight persons at the same ages in Mr. Pitt's tontines got	68.496
The shortcoming is only	2.637
In the same way eight persons aged 60, 55, 50, and 45 of 1693 obtained	132.584
Add one-fourth of itself	33.146
The increased sum is	165.730
But eight persons at the same ages in Mr. Pitt's tontines got	162.505
The shortcoming is only	3.225

But these shortcomings, small as they are, will ultimately vanish when Mr. Pitt's tontines are all extinct. His nominees have not yet attained their maximum of existence.

Again, eight persons aged 40, 35, 30, and 25, in the tontine of 1693 obtained	213.224
Add one-fourth of itself	53.306
The increased sum is	266.530
Whereas eight persons at the same ages in Mr. Pitt's tontines obtained	267.739

Being a small excess of 1.209, or one year and 73 days.

Once more, eight persons aged 20, 15, 10, and 4, in the tontine of 1693 obtained	295.887
To which add one-fourth of itself	73.972
The increased sum is	369.857
Whereas eight persons at the same ages in Mr. Pitt's tontines obtained	370.495

Being a small excess of .636, or 232 days.

On this evidence Mr. Finlaison justly observes that civilization could not have increased by a single leap in the time of

Mr. Pitt, but must have been slowly on the increase at least n ce the days of Queen Anne.

We may then fairly conclude, as I have just said, that in the interval between the close of the 17th and 18th centuries human life gained an addition equivalent to a fourth part of its whole term. What has it gained in the succeeding century? What has been the increase in the value of life in this first half of the century in which we ourselves have lived? Though unfortunately we can appeal to the results of no renewed tontine to enable us to answer this question with exactness,* yet there are not wanting evidences that the value of life continues progressively to increase. It must necessarily continue to increase, because the main conditions on which life and health depend have experienced, during the whole of the present century, an expansion and improvement, of which no former age presents a parallel. It will be sufficient to establish this fact, to glance at what has been effected within this period in the multiplication and diffusion of the three primary necessaries of existence—food, clothing, and fuel?

Such has been the increased production of food during the present century, that the quantity now raised maintains ten millions more human beings than existed at its commencement; for on the first enumeration of the people in 1801 the population of Great Britian was eleven millions; on the last, in 1851, it was twenty-one millions.†

This increased production of food consists chiefly of grain, green crops, and garden vegetables, countless in variety, and highly nutritious and grateful, completely reversing the nature of the national subsistence compared with that of former times, and giving to the masses of the people a constant and unfailing supply, winter and summer, of fresh vegetable nutriment.

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* Considering that there appears to be no objection in principle to the method of raising a loan by Tontine, and that the scheme is a popular one, it seems highly desirable that we should continue this means of measuring with positive exactness the results of our advancing civilization.

† Appendix No. V.

This increased production of food is mainly of home growth, for the supply of wheat from foreign sources would scarcely suffice to afford to each person two gallons of flour annually.

This increased production has been obtained partly by a progressive increase in the quantity of land brought under cultivation, which now amounts for the United Kingdon to upwards of 40,000,000 of acres, by far the greater part of which is employed in the production of human food; and partly by the employment of capital in the improvement of the soil, by which large tracts that a few years ago were wholly sterile, or deemed incapable of producing wheat, now yield some of the finest grain in England.*

This increased fertility of the soil renders it more healthy by diminishing its moisture and raising its temperature. One cubic foot of water in the process of evaporation deprives three millions of cubic feet of air of one degree of temperature. An undrained field growing rushes has a permanent temperature from four to six degrees lower than an adjoining field drained and growing wheat. By draining and manuring, by throwing down fences, by removing trees, by clearing underwood, and by promoting the free aëration of the soil, the temperature of large tracts of land in the north of England has been permanently raised three degrees. Thus that very culture of the earth, by which it is made to yield the largest amount of food, increases its salubrity as an abode for man, and lessens at their source the main causes of epidemics.

This increased production has been obtained by a proportionally small addition to labour; for while the quantity of land brought under cultivation and its produce, have been increasing at a rate of which there is no similar example in any age or country, the relative number of persons employed in agriculture has been as steadily decreasing. As long as the labour of a man applied to the cultivation of the soil is capable of producing only a bare subsistence for himself, there can be no advance in civilization. But when two men can produce

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*Appendix No. IV.

subsistence for three, the labour of the third can be set free for the production of surplus articles, which add to the sum of the general convenience, and from that moment the community takes a start in the career of improvement. From a comparison of occupations taken in 1831, it appears that, at that time, the division of labour among the people was such that one person raised nearly all the food of home production consumed by four persons.*

Were the remaining three idle? Mediately or immediately they were engaged in producing clothing, or fuel, or machinery, economizing the production of both; and busily and well they worked.

In number they exceed one million and a half. Taking into account the accessory occupations, indeed, no fewer than one million two hundred thousand are employed on one single material alone, namely cotton. For these workers, at the beginning of the century, there were imported yearly 56 millions of pounds of cotton: at present the annual importation of it exceeds 550 millions of pounds. These workers in 1820 were assisted in their operations by fourteen thousand power-looms; at present they are assisted by three hundred thousand power-looms, besides twenty-five millions of spindles;† while each power-loom, superintended by an adult assisted by a child, completes weekly twenty times the amount of work which the hand-loom is capable of producing. The increase of production is of course enormous, and the effect is a progressive cheapening of the articles manufactured, reducing the price of some of them tenfold, and placing them within the reach of the poorest classes:‡ articles of clothing not only conducive to health through warmth, but almost equally so through

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* Porter's Progress of the Nation, Chap. III.

† Return to the House of Commons by the Factory Inspectors, of the Number of Cotton, Woollen, Worsted, Flax and Silk Factories subject to the Factories Acts in the United Kingdom, page 21.

‡ The cheapness of some of these ornamental as well as useful fabrics is calculated to excite astonishment. A yard of platt net is worth from 20s. to £5; a yard of plain net may be bought for one shilling.

cleanliness ; for they are almost all composed of such tissues and textures as favour and compel frequent washing.

Gigantic strides have been made at the same time in another article of clothing, the basis of which is wool, and of which there were imported in 1801 seven millions of pounds ; in 1844, sixty-three millions of pounds. This enormous importation of foreign wool has not only not diminished its home growth, but the increased demand for it has led to a vast multiplication of the animals that yield it, and what is of equal importance, has induced an extraordinary care in improving their breed ; so that the very means which have fed the steam-engine have fed the people both with more plentiful and with better food ; the steam-engine, meanwhile, applied to these and to all manufacturing processes, being as much a producer of food as the plough.*

And the same is emphatically true of fuel, the main creator of all this activity and of its astonishing results ; this necessary of life being now brought to the door of every family in threefold abundance and at one-half the price at which it could have been obtained at the commencement of the century ; while such is the demand for it in various manufactures of vast magnitude, that one trade alone, that of iron, consumes annually eight millions of tons—a trade which immediately and powerfully facilitates the production both of food and of clothing. Thus, like one of Nature's beautiful adaptations, like that wonderful cycle, for example, in which production, change, and reproduction go on in an unvarying circle, the constant and abundant supply of one main necessary of life furnishes the means of producing the others ; while these last are the immediate causes of the abundance of the first.

And what a busy hive does this country present at the present time ! Out of every thousand males twenty years of age in the kingdom, 836 are directly employed in some active occupation contributing to the national wealth ; while the remaining

* Similar progress has been made in the manufacture of flax and silk as of cotton and wool.

114 are by no means idle, for they are engaged in some one of the professions.

The time will not allow me to trace in detail the effect of these combined causes in improving the condition of the masses of the people. Though they have not yet obtained their due share of the wealth they create, and though there is a class which in relation to one essential condition, to be stated immediately, civilization has scarcely reached, or reached only to injure—with these exceptions, no doubt very important ones—the evidence is indubitable that the entire body of society, from its base to its apex, stands on an elevated table-land which many centuries have been employed in raising and consolidating. I have partly proved this by showing the general diffusion of the means of healthful subsistence and the prolongation of life. I am now to prove it by applying these facts to the subject more especially before us, the decline and disappearance of epidemics.

It is now exactly two centuries, short of ten years, since the visitation of the Great Plague of 1665—that terrible disease which ravaged England for the space of 1249 years: for it is first heard of in English history in the year 430, and the last year in which its name appears in the Bills of Mortality is 1679; that terrible disease which not only maintained undiminished power over this vast space of time, but which sometimes recurred twenty times in one century—that terrible disease is gone. It cannot be supposed that it has worn itself out, for it still frequently returns with its ancient malignity to Constantinople, Alexandria, Smyrna, and other Eastern States.

Petechial or Jail fever, the fatal scourge of the ship, the prison, the hospital, the school, and in short of every place in which any considerable number of persons was assembled, and which when it once broke out was as destructive as the plague —that terrible disease is gone.

Intermittent fever, which in the middle of the fifteenth century and long afterwards recurred like the plague periodically but more frequently, and which often raged as universally, which was sometimes so mortal that the living could hardly bury the dead, and which spared not even the throne, for James I. and

Oliver Cromwell both died of ague contracted in London—that formidable disease is gone. Ague, it is true, still exists in the fenny and marshy places which yet remain in England, and we occasionally see a case contracted there in the wards of the London Fever Hospital, but I have not seen a single case of ague contracted in London for upwards of a quarter of a century.

Remittent fever is also gone, scurvy is gone, rickets is gone, malignant sore throat is gone, typhus-gravior is gone, and if small pox is not gone it is entirely the consequence of our own apathy and folly.

No less remarkable is the gradual decline and the ultimate cessation of certain forms of bowel-complaint of a very painful nature, the very names of which have long disappeared both from medical and popular language. In the 17th century the deaths from two of these diseases alone registered in the Bills of Mortality under two separate titles, were never less than 1000 annually, and in some years they exceeded 4000; but from having been 1070 in the year 1700, they decreased through each successive decade of that century in the following remarkable progression: 770, 706, 350, 150, 110, 80, 70, 40, 20; and they have so entirely disappeared during the 19th century, that, as I have just said, their very names are no longer in use.

Moreover several acute diseases which hardly come under the name of Epidemics, such as Rheumatic Fever, Pneumonia, and Peripneumonia, are much less frequent and fatal now than they were a century ago.

All this time there has been a continually decreasing mortality. In 1700 the estimated mortality of England and Wales was 1 in 39; in 1750 it was 1 in 40; in 1801 it was 1 in 44; in 1810 it was 1 in 49; in 1820 it was 1 in 55, and in 1830 it was 1 in 58.

In London in 1700* the deaths were 1 in 25; in 1750, 1 in 21;† in 1801, 1 in 35; in 1810, 1 in 38; and in 1830, 1 in 45.

* Parliamentary Returns, 1811.

† It is conceived that the remarkable increase of the mortality in the middle of this century was mainly caused by the abuse of spirituous liquors, which was checked about that time by the imposition of high duties.—*Sir Gilbert Blane's Disserations.*

The diminishing number of those who are born merely to die exhibits the decrease of mortality in a still more striking point of view. The estimated mortality of persons under twenty years of age in London in 1780 was 1 in 76; in 1801 it was 1 in 96; in 1830 it was 1 in 124; in 1833 it was 1 in 137; not much more than one-half the proportion who died under twenty half a century ago.

The contrast between the mortality of former times and of the present is seen in the mortality of London in 1685 and in 1830. In the first period the deaths were 1 in 23; in the second they were 1 in 45, little more than one-half. Truly therefore has it been said by your President, that the salubrity of London in the nineteenth century and of London in the seventeenth is far greater than the difference between London in an ordinary season and London in the cholera.

But still we have had Cholera. In less than a quarter of a century we have had three visitations of this dreadful disease, which exhibits the essential characters of a pestilence of the middle ages; and if Typhus-gravior has disappeared, Typhus and its kindred diseases have taken its place; and the Registrar-General constantly presents before our eyes a faithful record of their ravages.

This is too true. We still have epidemics—and why? Because in all our towns there are large portions of the people who live in a state essentially the same as that which existed in the middle ages. The conditions are similar; the results are similar.

It is this unhappy class of people that form the exception to the general progress of the nation to which I have adverted.

These wretched places and their inhabitants do not obtrude themselves on the public eye. They are not seen in our common thoroughfares, nor in our splendid streets and squares. They are not known. The medical man knows them, the minister of religion knows them, the relieving officer knows them, a few dispensers of voluntary charity know them. They are not known to any one else in this assembly.

Let me take you then to one.

It is a small room, say twelve feet square; an inner room; no chimney, no window that will open, no inlet for fresh air, no outlet for foul air. There, on a miserable bed, lies a woman ill of typhus fever; a child at her side on the same bed is dying of that fever; a child already dead of it is stretched out on a table at the bed-side.

I could not breathe the air of that room. I could not remain in it long enough to write a prescription for the poor patients. As I was writing it at the street-door I shivered and felt sick. I knew that I had taken fever. I passed through a very severe form of it. I could take you to hundreds of such houses in every part of London; to hundreds of courts and lanes wholly consisting of such houses.

In such houses, with the conditions of the 15th and 16th centuries, Cholera, in the middle of the 19th, found and exerted a power similar to that which characterized the epidemics of the middle ages, and here Typhus and its kindred diseases continually hold their undisputed reign: houses whose unhealthfulness is increased by the only marks of the age which attach to them, their brick construction and their glass windows; those bricks and windows more effectually than the ancient wattles excluding the external, and confining the internal air, and thereby fostering the generation and spread of typhus. It is remarked by Dr. Macculloch, in his account of the Hebrides, that while the inhabitants had no shelter but huts of the most simple construction which afforded free ingress and egress to the air, they were not subject to fevers, but when such habitations were provided as seemed more comfortable and commodious, but which afforded recesses for stagnating air and impurities, then febrile infection was generated. Houses in this state, without ventilation, without the means of cleanliness, worse than the huts of the savage, exist in great numbers in all our towns, and too truly merit the name they have acquired of "fever nests."

I once took a distinguished statician of France to some of these places in London, and showed him the sick with typhus

lying in their wretched beds; for the sick with typhus may be seen there every day of every year. After the painful inspection he exclaimed—"England is indeed adorned with a splendid mantle, but under it are concealed the greatest horrors."

Determined that this eminent person should see both sides of the picture, I next took him to the Model Dwellings.

What are the Model Dwellings? Small plots of civilization cultivated in the midst of a wide waste of barbarism.

In what does their civilization consist? In very simple matters.

The subsoil drainage of the site of the building;

The free admission of light and air to each inhabited room;

The abolition of the cess-pool, involving complete house drainage, an abundant supply of water, and the immediate removal by it of all refuse which it is capable of holding in suspension;

Means for the removal of house refuse not capable of suspension in water.

And this is all. And what are the results of these few and simple arrangements?

That the mortality among the inhabitants of these dwellings is one-half less than that of London generally, and three times less than that of some of the filthy and neglected localities in London, the Potteries of Kensington for example; while the mortality among children under ten years of age, on an average of three years, is one-half less than that of the nation generally, and four times less than that of the potteries;

That there has not been a single death from typhus, or any other form of continued fever, among the adults in any of these buildings since their establishment; and that during the two first visitations of epidemic cholera, with the exception of two cases which occurred under peculiar circumstances, there was no attack of cholera in any of these buildings, while from four to six deaths from the pestilence occurred in single houses in the immediate neighbourhood.

There is before you a Table* which exhibits at one view the particular facts which justify these statements.

Such are the results of the first imperfect attempt at improvement; which, remarkable as they are, are not more striking than the results of neglect. Of the children born in the best part of a town one fifth die before they attain the fifth year of age; of the children born in the worst, one half die before they attain their fifth year. The inhabitants of the worst localities attain little more than one half the age of those who live in the best. Of 100,000 children born in Surrey, 75,423 attain the age of ten years; 52,000 live to the age of fifty; and 28,878 live to seventy. In Liverpool, out of 100,000 persons born, only 48,211 live ten years; 25,878 live fifty years; and 8,373 live seventy years. The probable duration of life in Surrey is 53 years; in Liverpool it is 26 years. Were the whole of the metroplis as healthy as the Model Dwellings, there would be an annual saving in London of 23,000 lives. But these lives are not saved; this number of persons is allowed to perish every year, and they are as truly and as needlessly sacrificed as if they were taken out on Bethnal-green and shot.

When we bear in mind the suffering which in every case accompanies this waste of life, and the suffering which must inevitably follow it, and remember that it is admitted that these dreadful evils are remediable and preventible, it is difficult to suppress the natural feelings of indignation and of sorrow, that in a country calling itself Christian the application of the known remedies should be so long delayed.

It is right however to acknowledge that something has been done, and is in progress for the improvement of the sanitary condition of the people. The principle is admitted that it is the duty of the Legislature to deal with this matter, and the first systematic legislative effort to bring about a better state of things has been made. It may interest you to know to what extent and with what results.

The Public Health Act is in operation, and the general and

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* Appendix No. VI.

proper application by local authorities of the powers it confers would place every part of every town in Great Britain in as good a sanitary condition, at least, as that of the Model Dwellings.

Up to the present time there are under this Act 196 towns, containing a population of upwards of 2¼ millions. In about 50 of these towns, however, nothing has yet been done.

Eleven towns, with a population of about half a million, have adopted the powers of the Act in subsequent local acts.

Works of drainage and water supply are completed, or are in an advanced state, in 70 towns.

Mortgages have been sanctioned—

For drainage works and water supply,.....	nearly 1¾ millions sterling ;
For private works of drainage and water supply, ...	about £45,000 ;
For paving, street improvements, &c.,.....	about £200,000 ;

Making a total of nearly two millions sterling devoted to sanitary improvement.

It is difficult at present to give the average cost of these combined and complete sanitary works ; but the total expense for public and private works of drainage and water supply for houses of from £10 to £20 per annual rental, may be taken at 4d. per week per house.

The great obstacle to sanitary progress is the fear of rates, not so much on the part of the poor, who gladly pay for the improvements, but on the part of the owners of small tenements, by whom chiefly opposition is raised to the application of this Act.

I may state in conclusion, that you may examine for yourselves a specimen of these works at no great distance, namely in the town of Alnwick, where public and private works of sewerage and drainage have been nearly completed. You will there see laid down about twenty miles of sewers and drains, and seventeen miles of apparatus for water supply, at a total cost, for the combined works, of 4d. per week per house for

the term of thirty years ; after the expiration of which period the cost of the works, both principal and interest, will have become liquidated, and the only expense thereafter will be for maintenance.

On inspecting these works in my way here, I saw in the tenements occupied by the lowest classes a high degree of cleanliness, wholesomeness, and comfort, and heard from the inhabitants an expression of the greatest satisfaction. I have placed in the library of this Institution for inspection an elaborate abstract exhibiting a detailed account of the expenditure relating to these sanitary works.

We have as yet no certain knowledge of the extent to which such works are capable of preventing sickness and lengthening life. But the most perfect drainage, combined with the most ample supply of water, will not alone secure for the public health all which it is practicable to accomplish. There must also be provision for the better construction of the houses of the poor ; for the prevention of over-crowding ; for street ventilation and cleansing, and for the exclusion from the neighbourhood of human dwellings of filth-creating animals and of noxious trades. When all this is done, as it might be done, and as it would be done were there a general perception of the crying evils it would remedy, Epidemics would disappear, the more formidable of them immediately, and all of them, I believe, in the end.

From the whole of the facts and observations which I have now laid before you, we see—

1. That Epidemics are under our own control ; we may promote their spread ; we may prevent it. We may secure ourselves from them. We have done so. We have banished the most formidable. Those that remain are not so difficult to be conquered as those that have been vanquished. The causes of Typhus are more completely under our control than those of Intermittent. We have banished Intermittent. We may put an end to typhus. We have actually done so. We have encompassed the Model Dwellings by a barrier which neither typhus, nor even cholera, nor any of the other causes of exces-

sive sickness and premature mortality have been able to pass. To the residents within that barrier the chance of life has been doubled; to their children it has been more than doubled; and compared with some other children of their own class it has been increased fourfold.

You have Model Dwellings in Edinburgh. I hope you will improve and multiply them. These dwellings present before the public a practical example of what it is possible to do. They may awaken the public conscience to a sense of what it is a duty to do. In those peaceful homes, in the temperate and industrious habits they form and foster, in their freedom from sickness and their lengthened life, are exemplified what it is in our power to make the common lot.

Why has Edinburgh no Public Health Act?

You have done much for the adornment of your city, endowed with extraordinary natural beauty. Would it not be a completion of your work to render it as remarkable for its salubrity? It might be so: no town in the kingdom offers greater facilities for the application of the measures which would make it so. In your broad streets, the freshness of the air from the sea and the hills that seem at our feet, gives us the impression that we are at the sea-shore or on those hills, instead of in the heart of a city. Why do you allow your back streets, your closes, your wynds, to poison that pure air —God's precious gift?

Why has Edinburgh no Public Health Act? Do you not require its powers? Are all your streets sewered? Are all your houses drained? Is every dwelling supplied with the ready means of removing house refuse? Have you no epidemics, no fevers? In and about your houses is there no pabulum, no removeable pabulum, to nourish and sustain these cruel diseases?* If you do not possess the necessary authority for putting your town in order, if you cannot carry into effect the

* Since this Lecture was delivered I have been informed that earnest efforts have been made for the extension of Drainage Works, with such powers as exist under a Local Act, and that Duncan M'Laren Esq. has devoted himself to this most important object.

combined works which are indispensable for checking these maladies, and if you will not apply for such powers and will not use them, on your own heads are the shame and the crime of the needless loss of life—the needless infliction of suffering.

2. We see that epidemics are not made by a Divine law the necessary condition of man's existence upon earth. The boon of life is not marred with this penalty. The great laws of nature, which are God's ordinances in their regular course and appointed operation, do form and give off around us, products which are injurious to us; but He has given us senses to perceive them, and reason to devise the means of avoiding them, and epidemics arise and spread because we will not regard the one, nor use the other.

3. We see that there are circumstances which render it doubtful whether civilization has yet attained a point that places it beyond the danger of retrogression. States in some respects of higher civilization than our own have relapsed into barbarism. There is indeed one circumstance which may give us hope; there is one humanizing principle which is now at least recognised and in partial operation, of which there is no trace in any nation of antiquity. I mean the principle of kindness as a governing influence, distinguished from the principle of brute force.

That the whole human race is one family, that the people of every colour, clime, language, government, and faith, are one brotherhood, and that the same law of love which is the bond of the union, strength, and happiness of a single family, is equally binding on the universal family of mankind, are the fundamental and distinguishing principles of our religion; and in proportion to our conformity in our private and public life to the spirit of these divine principles, advancement in civilization is certain; relapse into barbarism is impossible. But as yet there is no such conformity. We neglect the education of the people, quarrelling about the mode, and postponing the thing. We devote to a life of absorbing labour the child and the youth ungrounded in the elements of knowledge, untrained to habits of self-restraint, thereby dooming the man to the

blankness and turbulence of ignorance and intemperance. We equally neglect the sanitary condition of the people. We make no provision for securing to the humblest classes, and they can make none for themselves, the conditions that are essential to their physical health, the loss of which to them involves and includes every other. We thus neglect body and mind, and then the disorders and vices which necessarily follow we endeavour to repress by punishments that harden but never reform, neither trusting nor trying the influence of gentleness which our religion teaches us is stronger than ignorance, stronger than crime, and can master both. It is this state of things that places in danger the ark of civilization.

Lastly, we see the first step that must be taken to elevate the people: nay even to bring them within the pale of the civilization already attained. We must improve their sanitary condition. Until this is done, no civilizing influence can touch them. The schoolmaster will labour in vain; the minister of religion will labour in vain; neither can make any progress in the fulfilment of their mission in a den of filth. Moral purity is incompatible with bodily impurity. Moral degradation is indissolubly united with physical squalor. The depression and discomfort of the hovel produce and foster obtuseness of mind, hardness of heart, selfish and sensual indulgence, violence and crime. It is the Home that makes the man; it is the home that educates the family. It is the distinction and the curse of Barbarism that it is without a home: it is the distinction and the blessing of Civilization that it prepares a home in which Christianity may abide, and guide, and govern.

APPENDIX.

No. I.

EXTRACTS FROM PARISH REGISTERS.

Amongst the entries in Parish Registers still extant which afford authentic evidence that besides the great epidemics which from their universality have become national and historical events, there constantly occurred outbreaks of great severity, the following may be cited :—

Stranton, County of Durham.—Here began the sickness 21 May 1597—during which 93 died, and whole families were swept away.

St. Nicholas, Durham.—1597. In this year was the great visitation in the Citie of Durham. Between 10 July and 27 Nov. 210 were buried of the plague.

St. Giles, Durham.—Ann Ourd, wyffe of Christopher Ourd, bur. 25 Jan. 1604. So all the hole household dyed in the visitacion at this time, and so the plague ceased.

Richmond, Yorkshire.—17 Ap. 1597. The plague began. Roger Sharpe was the first who died of it. It prevailed till Dec. 1598 ; 1050 died.

St. Nicholas, Bristol.—1546. This year the Citty of Bristol was visited with the plague, so that 146 died in one week.

No. II.

WITCHES.

The number of wretched beings condemned and executed for this imaginary crime at the Assizes of Suffolk and Essex alone in the year 1646, amounted to two hundred. Dr. Zachary Gray affirms that he had seen an authentic account of persons who had so suffered in the whole of England, amounting to from three to four thousand. So late as the year 1697 seven persons, three men and four women, were burnt at Paisley for this alleged crime. We seldom sufficiently consider how near we are to those times of dreadful superstition and cruelty! How short a period it is since the light of a brighter day dawned upon us!

No. III.

DIFFERENCE IN EXPECTATION OF LIFE.

Male Sex.

Age, . .	15		20		25		30		35		40		45		50	
	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.
Tontine of 1789,	42	3	38	11	36	6	33	9	30	8	27	5	24	1	20	1
Tontine of 1693,	32	5	29	5	28	3	26	8	24	6	22	0	19	7	16	10
Difference, .	9	10	9	6	8	3	7	1	6	2	5	5	4	6	3	3

Female Sex.

Age, . .	15		20		25		30		35		40		45		50	
	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.	Yrs.	Mos.
Tontine of 1789,	46	5	43	2	39	11	36	6	33	2	29	9	26	3	22	10
Tontine of 1693,	37	7	34	7	31	11	29	4	26	8	24	0	21	3	18	7
Difference,	8	10	8	7	8	0	7	2	6	6	5	9	5	0	4	5

INCREASED PRODUCTIVENESS OF SOIL.

"In 1821 almost the only grain produced in the Fens of Cambridgeshire consisted of oats; since then, by draining and manuring, the capability of the soil has been so changed that these fens now produce some of the finest wheat that is grown in England; and this more costly grain now constitutes the main dependence of the farmers in a district where 14 years ago its produce was scarcely attempted."—*Porter's Progress of the Nation.*

No. V.

PROGRESS OF POPULATION.

According to Mr. Rickman, from the best information that can be obtained from Doomsday Book, the population of England in the time of William the Conqueror was 1½ millions.

In the reign of Edward the Third (1377), when a poll-tax was imposed on all persons of both sexes above fourteen, it was 2½ millions.

In the reign of Queen Elizabeth, at the period of the Spanish Armada, it was 4½ millions.

According to Mr. Finlaison, at the close of the 16th century it was somewhat under 5 millions two hundred thousand.

According to Mr. Rickman, on a computation founded on the return of Baptisms, as stated in the Abstract of Parish Registers, it was in 1700, 5½ millions; in 1750, 6½ millions; and in 1770, 7½ millions.

The first actual enumeration was made in 1801. The following table exhibits the rate of Increase in the population of Great Britain from that time up to the last enumeration in 1851:

Years.	Population.	Increase Each Decennial period.	Annual Rate of Increase per cent.
1801	10,917,433		
1811	12,424,120	1,506,687	1.274
1821	14,402,643	1,978,523	1.489
1831	16,564,138	2,161,495	1.408
1841	18,813,786	2,249,648	1.279
1851	21,121,967	2,308,181	1.186

No. VI.

COMPARATIVE VITAL STATISTICS.

Locality and Period.	Average Population.	Average Mortality.	Average proportion of Deaths to 1000 living.
All Ages.			
Metropolitan Buildings (Old Pancras Road), during five years, . .	649	9	13.9
London (same five years), . .	—	—	24.1
All the Metropolitan Association Establishments (during three years),	1426	18	12.6
London (same three years), . .	—	—	25.4
The Potteries (Kensington), one year (1852), ...	1263	51	40.0
Metropolitan Buildings (Cholera year),	—	—	12.9
London, 1854 (same year), . .	—	—	29.4
Children under Ten Years of Age.			
Metropolitan Buildings (during three years), ...	408	11	27
London, one year (1852), . . .	—	—	46
Potteries (same year), * . . .	384	42	109

* The proportion in the Metropolitan Buildings during that year was only 10.

No. VII.

LETTER from John Finlaison, Esq., President of the Institute of Actuaries, to Dr. Southwood Smith.

Richmond, 23*d October* 1855.

My Dear Sir,

I am very willing to comply with your wish to be distinctly informed of the evidence on which rests a most remarkable fact in the history of the human species—namely, the prolongation of the life of man from the duration to which it had attained, reckoning from the year 1690 in the time of William and Mary, to the amount at which it now stands, reckoning from the year 1790 in the time of Mr. Pitt.

It happened that in each of those years, the interval being exactly a century, a Loan for the service of the State was raised by the method of a Tontine.

In a Tontine, the person who advances £100 is at liberty to name any life he pleases, during the existence of which he draws a certain annuity; and as the shares of the dead nominees are distributed among the living ones, that annuity continually increases until the last survivor gets the whole income.

It would seem, therefore, that there is the strongest inducement that the shareholder should carefully select from among the youngest infants within his reach, the very healthiest he can find.

This power of selection, however, is practically restricted within very narrow limits. The owner cannot draw the annuity without proof of the existence of his nominee at the time, and he cannot easily keep sight of a child grown up and sent out into the world, unless the child were his own, or at least a very near relative.

Thus although individual selection does not count for much, it is nevertheless the case that the nominees of a Tontine are collectively a select class. They are the children of such wealthy persons as are able to lend money to the State, and in the expectation of life have obviously some advantage—the Female sex especially—over their contemporaries in society at large, the vast majority of whom are of the labouring poor. But when we compare the fate of the nominees of one Tontine with that of the nominees in any other, it is evident that the circumstances of the parties in each Tontine are in almost every case precisely the same. We ought therefore in this comparison to have an accurate measure of the effect produced on the duration of human life by such changes in the social condition of a people, as may have occurred in the lapse of a considerable space of time, provided, however, that both Tontines are extinct—not otherwise so exactly as is possible.

King William's Tontine consisted of 408 Females and 594 Males, *all selected* by the proprietors. With the exception of one female life, this Tontine became extinct before the year 1773.

Mr. Pitt's last Tontine contained 3974 Females and 4197 Males. They were not all selected by the proprietors. On the contrary, for every 33 lives so selected, there were 48 lives chosen by lot. The cause was this. Ten thousand shares were to be filled up, but only two-fifths of the shareholders took the trouble of finding nominees—the others exchanged their shares for the present long annuity which expires in 1859. To keep faith with those who had made their selection, the Curates throughout England were invited to send a list of such of the children of persons of note in their respective parishes as were likely to be kept sight of in after life; and from these the deficient lives were made up under the title of "Government Nominees," as distinct from those of the contributors.

But this Tontine is *not extinct*—very far from it. On 1st January 1851, there remained alive 1312 Females out of the original 3974, and 977 Males out of the original 4197. They were *alive* at all ages from 60 and upwards, and there is good reason for thinking that the duration of life in future store for them will in the mass be greater than that which has actually been accorded to equal numbers of their contemporaries who have already *died* at all ages above 60. The mere fact that the former are still above ground is in their favour.

You will therefore clearly understand, that when I show you, as I am about to do, the remarkable difference between the mortality which has occurred to the subjects of King William's Tontine, and that which has already occurred in the case of Mr. Pitt's great Tontine, commencing a century later, that difference is not yet so great as it will ultimately prove to be.

Previously to the last Tontine of 1790, Mr. Pitt had instituted three small Tontines—one in 1774, another beginning in 1776, and a third, in 1778. These are commonly called the "Irish Tontines," not because the nominees were of Irish parentage, but simply because the money lent was raised for the service of Ireland, and advanced most likely by English capitalists.

In these collectively there were 1569 Female Nominees, of whom 187 were still alive in Jan. 1851. There were also 1415 Male Nominees, of whom only 91 survived. Those Nominees were all selected by the contributors themselves. What was the effect of that entire selection, as compared with the partial selection in Mr. Pitt's last Tontine, will be rendered apparent immediately.

One word more before entering on the facts or data which I am to exhibit. The deaths of both sexes under 11 in the older Tontine were only 35; of these 17 were Females and 18 were Males. This is an accidental anomaly. In the reasoning I have, for technical considerations too long to enter on, assumed that there ought to have been only 13 Females and 22 Males. While therefore every one of the facts given in on oath as they originally were, are literally set forth, justly and truly as they result from the record, the arithmetical conclusions are, with this single exception, such as every man may verify for himself.

Let us distinguish the numbers applicable to the Female Sex in the Tontine of King William by the letter A; those of the Male Sex by d. The Females in like manner of Mr. Pitt's last Tontine by the letter B; while the Males of the same are indicated by b. Lastly, the Females of the Irish Tontines by the letter C; while the Males of the same are shewn by c. Finally, let the letter L denote the total number subjected to the risk of mortality in each interval of life, as specified, while the mark D signifies the number who died in such interval.

We shall have the following facts:—

Female Sex.	A		B		C	
	L	D	L	D	L	D
Under the age of 11	1,181	17	9,937	69	5,352	31
Above 10—under 21	2 949	23	24,942	191	11,720	73
Above 20—under 28	2,290	36	21,480	161	9,844	93
	6,420	76	56,359	421	26,916	197

We shall not have a clear perception of the relation of those numbers to each other, unless we survey them by one measure common to them all. For this purpose we shall suppose that Ten Thousand persons had been the number which had passed through each and every interval of age, in each of the three Tontines in question, instead of the various numbers above set forth according to the facts.

On that supposition, the numbers of the Dead would, by the rule of three, be as follows:—

	A	B	C
Under the age of 11	110	70	58
Above 10—under 21	78	77	62
Above 20—under 28	158	75	94
Out of 30,000 persons The Total Deaths are	346	222	214

So that under the age of 28, in regard to the Female Sex, if 10,000 *Deaths* had taken place in King William's Tontine,

There would have died in Mr. Pitt's last Tontine, 6,416
And in the Irish Tontines, - - - 6,185

Proceed we now to the Male Sex under 28. The facts are as under.

Males.	a		b		c	
	L	D	L	D	L	D
Under the age of 11	1 887	18	9,406	71	3,921	23
Above 10—under 20	3,904	42	19,807	152	7,331	53
Above 19—under 28	3,558	95	21,062	278	7,557	107
	9,359	155	50,275	501	18,809	183

So that out of 10,000 persons alive at each interval, the Deaths would, by proportion, be as below:—

	a	b	c
Under the age of 11	118	75	59
Above 10—under 20	108	77	72
Above 19—under 28	266	132	142
Out of 30,000 persons The Total Deaths are	492	284	273

With regard, therefore, to the Male Sex under the age of 28, it results that for every 10,000 which would have died in the Tontine of King William,

There would have died in the last Tontine of Mr. Pitt, 5 772
And in the Irish Tontines, ... 5,548

It now appears that there is in each of the three Tontines a most important difference in the rate of mortality to which in this portion of life the two sexes are liable, for out of the self-same number of the living of each sex,

	A	B	C
The Deaths of the Females are.....	346	222	214
While those of the Males amount to.....	492	284	273

Therefore if 10,000 *Males* had died out of

The Tontine of King William, The Deaths of the Females would be	7,033
That of Mr. Pitt in 1790, . . „ . . „ . „	7,817
The Irish Tontines, . . „ . „ . „ .	7,839

We shall see presently how far this differenee will prevail in the middle and advaneed periods of life.

Taking the middle period of life above 27, aud for the female under 57, but for the male under 56 years of age, the Faets are as under :—

The Female Sex.	A		B		C	
	L	D	L	D	L	D
Above 27—under 35.....	2 145	35	21,979	195	10,323	108
„ 34 „ 42.....	1,936	34	21.507	209	10.226	114
„ 41 „ 49.....	1,719	41	20.551	250	10,090	124
„ 48 „ 57.....	1,622	47	21,643	334	10,799	163
	7,422	157	85,680	988	41,438	509

Then, by proportion, out of 10,000 persons alive in eaeh interval, the Deaths would be as under :—

	A	B	C
Above 27—but under 35.....	168	89	105
„ 34 „ 42.....	176	97	111
„ 41 „ 49.....	238	122	123
„ 48 „ 57.....	290	154	151
Total Deaths out of 40,000, ...	872	462	490

Then for every 10,000 deaths which took place in King William's Tontine,

The Female Deaths in Mr. Pitt's last Tontine would only be	5,298
Aud in the Irish Toutines, ...	5,589

With regard to the Male Sex, in very nearly the same period of life, the faets are as below,—viz.

Male Sex.	a		b		c	
	L	D	L	D	L	D
Above 27—under 38	3,843	79	26.759	309	9.637	116
„ 37 „ 48	3,179	78	27,098	348	9.756	126
„ 47 „ 56	1,994	65	21,123	388	7,407	148
	9,018	222	74,930	1,045	26,800	390

Then, by proportion, out of 10,000 persons alive in eaeh interval of age the Deaths would be as under :—

	a	b	c
Above 27—but under 38	206	115	120
„ 37 „ 48	245	128	129
„ 47 „ 56	326	184	200
Total Deaths out of 30,000 persons,	777	427	449
Then the proportion out of 40,000 will be	1036	569	559

It results, that for every 10,000 males which might have died at this period of life out of the Tontine of King William,

The Deaths according to the last Tontine of Mr. Pitt would only be	5,492
And according to the Irish Tontines, only . . .	5,782

In regard to the difference in the rate of mortality of the respective sexes from 27 to 56, we have, out of one and the same number of living persons, the following Deaths,—viz.

	A	B	C
Of Females as above,.....	872	462	490
But of Males,.....	1,035	569	559
	a	b	c

Therefore, if 10,000 Males had died in the Tontine of King William,
The Deaths of the contemporary Females would be . 8,417

And if the like 10,000 had died on Mr. Pitt's last Tontine,
The Deaths of the Females would be . . . 8,120

Lastly, if the same 10,000 *Males* had died in the Irish Tontines,
The Deaths of the contemporary Females would have been 8,180

I now proceed to the more advanced period of life, including all persons under the age of 84,—the Females above 56, the Males above 55. The Facts are as under.

The Female Sex.	A		B		C	
	L	D	L	D	L	D
Above 56—under 62,.....	510	30	12,099	248	4,080	123
„ 61 „ 72,....	1,235	58	14,785	547	9,774	398
„ 71 „ 77,.....	359	35	3,025	199	3,054	221
„ 76 „ 84,.....	254	40	1,610	275	1,969	230
	2,658	163	31,519	1,169	18,877	972

I may add, for the information of those who are not aware of the exact import of a decimal fraction as a measure of time, the following Table of the Expectation of Life in years and weeks:—

Female Sex.

Age.	*In King William's Tontine.* Yrs.	Wks.	*In Mr. Pitt's four Tontines.* Yrs.	Wks.	*Excess of Existence obtained by the latter.* Yrs.	Wks.
90	2	26	2	45	0	19
85	2	46	4	6	1	12
80	4	16	5	32	1	16
75	6	4	7	36	1	32
70	8	17	10	6	1	41
65	11	3	12	46	1	43
60	13	36	15	2	2	18
55	16	7	19	23	3	16
50	18	30	22	45	4	15
45	21	12	26	14	5	2
40	24	0	29	38	5	38
35	26	35	33	10	6	27
30	29	16	36	26	7	10
25	31	48	39	50	8	2
20	34	31	43	1	8	22
15	37	31	46	2	8	23
10	41	5	51	10	10	5
4	44	20	53	33	9	13

MALE SEX.

Age.	*K. W.'s Tontine.* Yrs.	Wks.	*Mr. P.'s Tontines.* Yrs.	Wks.	*Excess by latter.* Yrs.	Wks.
90	2	26	2	45	0	19
85	3	15	3	40	0	25
80	4	14	5	9	0	74
75	5	37	6	40	1	3
70	7	23	8	41	1	15
65	9	35	11	24	1	41
60	12	8	14	17	2	9
55	14	24	17	20	2	48
50	16	42	20	6	3	16
45	19	30	24	7	4	26
40	21	51	27	22	5	23
35	24	24	30	34	6	10
30	26	35	33	39	7	4
25	28	11	36	28	8	17
20	29	23	38	49	9	26
15	32	20	42	14	9	46
10	36	7	46	11	10	4
4	40	14	49	39	9	25

It is now evident that, *age for age*, the excess of existence obtained by the *Female* over and above that allotted to the *Male* is as under:—

Age.	*In King William's Tontine.* Yrs.	Wks.	*In Mr. Pitt's four Tontines.* Yrs.	Wks.
80	0	2	0	23
75	0	19	0	40
70	0	43	1	17
65	1	20	1	16
60	1	28	1	34
55	1	34	2	3
50	1	38	2	39
45	1	34	2	24
40	2	1	2	16
35	2	11	2	28
30	2	33	2	39
25	3	37	3	22
20	5	8	4	4
15	5	11	3	40
10	4	50	4	51
4	4	6	3	46
Total,	40	10	40	5

There is in all this something very like *internal* evidence of the accuracy of the Law of Mortality which I have inferred to prevail at each of the periods under consideration, separated as they are by a century.

But we are not left solely to the facts derived from the Tontine of William and Mary for the establishment of so eminent a truth in the national history of man, as this increase in his longevity is proved to be.

The records of the town of Northampton for the year 1755, in which was found its population at each age (a city of shoemakers they were), and the baptisms and burials from 1746 to 1766, enabled Dr. Price to

construct the well-known Northampton Table, according to which the public life-annuities in this country were sold, down to the year 1830—thereby entailing a loss of many millions to the revenue, and an equal profit to the fortunate annuitants. There are few persons unaware that this ruinous table was persisted in, notwithstanding my own reiterated and vehement remonstrances, continued incessantly during a period of ten years previously to its abolition.

Dr. Price made no distinction of Sex. To compare the results of his Table with those arising from the Tontine of King William, it was necessary to construct a table from the latter, in like manner without distinction of Sex. The effect in the expectation of Life is as under, in years and weeks :—

Age.	*By the Northampton Table.* Yrs. Wks.	*By King William's Tontine.* Yrs. Wks.	*The Excess of existence at Northampton.* Yrs. Wks.	*The Deficiency as compared with King William's Tontine.* Yrs. Wks.
90	2 21	2 26	0 0	0 5
85	3 19	3 4	0 15	
80	4 39	4 15	0 24	
75	6 28	5 46	0 34	
70	8 31	7 48	0 35	
65	10 46	10 19	0 27	
60	13 11	12 48	0 15	
55	15 30	15 15	0 15	
50	18 0	17 36	0 16	
45	20 27	20 21	0 6	
40	23 4	22 51	0 5	
35	25 35	25 30	0 5	
30	28 14	27 51	0 15	
25	30 18	30 4	0 14	
20	33 23	32 1	1 2	
15	36 27	35 0	1 27	
10	39 41	38 32	1 9	
4	40 30	42 17	0 0	1 39

From those facts it results, that out of 10,000 Females alive at each interval of age, the Deaths would be as under,—viz.

Females,	A	B	C
Above the age of 56—under 62	370	205	203
„ 61 „ 72	470	370	407
„ 71 „ 77	975	658	724
„ 76 „ 84	1,575	1,087	1,168
Total Deaths out of 40,000,	3,390	2,320	2,502

Whence it appears that for every 10,000 deaths which might have occurred in the Tontine of King William,

The Female Deaths in the last Tontine of Mr. Pitt would be 6844
And in the Irish Tontines 7381

In regard to the Male Sex at this period of life, the facts are—

	a		b		c	
	L	D	L	D	L	D
Above 55—under 64	1,524	67	18,123	550	6219	167
„ 63 „ 70	785	47	8,824	394	3666	164
„ 69 „ 74	356	33	3 503	257	1807	141
„ 73 „ 84	395	57	3,382	388	1942	220
	3,060	204	33,832	1,589	13,654	692

From those facts we conclude, that out of 10,000 males alive at each interval of age, the Deaths would, by proportion, be as under :—

	a	b	c
Males above the age of 55,—but under 64	440	303	269
„ 63 „ 70	599	446	447
„ 69 „ 74	927	734	780
„ 73 „ 84	1,443	1,147	1,121
Total Deaths out of 40,000,	3,409	2,630	2,617

Whence it appears, that for every 10,000 Deaths which might have occurred in the Tontine of King William,

Tho Male Deaths in the last Tontine of Mr. Pitt would be 7715
And in the Irish Tontines 7677

The intervals of age within which it has been necessary to group the Facts (in order to discover the Law of mortality) are in this period of Life very different in the respective Sexes,—a circumstance of great importance in old age. No satisfactory comparison by means of these groups can therefore be made in this period between the mortality of females and males, although no truth is now more certain than that the Female vitality is much the greatest here as elsewhere. This will be evident from the facts in extreme old age, few in amount although they be, which yet remain to be exhibited.

Females	A		B		C	
	L	D	L	D	L	D
Above 83 years of age	52	12	427	84	523	104
Out of 10,000 living,						
The Deaths would be	2,308		1,967		1,989	

Then for every 10,000 deaths out of the Tontine of King William,

The Deaths out of the Tontine of Mr. Pitt would be . 8523
And out of tho Irish Tontines 8618

Males	a		b		c	
	L	D	L	D	L	D
Above 83 years of age	46	13	378	88	288	59
Ont of 10,000 living,						
The Deaths would be	2,826		2,323		2,049	

Then for every 10,000 deaths which might have happened in the Tontine of King William,

The Deaths out of that of Mr. Pitt would be . . . 8234
And out of the Irish Tontines 7250

The ages in this period of life being the same for each sex, we can observe the rate of mortality of the males and females respectively in extreme old age.

We see that out of the self-same number of the living above 83,

	A	B	C
The Deaths of the Females are.....	2328	1967	1989
While those of the Males are.....	2826	2323	2049

	a	b	c
Therefore, if 10,000 Males had died out of the Tontine of King William, There would die of their contemporary Females . . .			8167
And if the like 10,000 Males had died in the last Tontine of Mr. Pitt, The Deaths of their contemporary Females would have been			8449
Lastly, if the like 10,000 Males had died out of the Irish Tontines, The Deaths of their contemporary Females would have been			9707

It is very likely that those who have given but slight attention to investigations of this sort, will imagine that 408 females and 594 males, being all the Facts which we have in the Tontine of William and Mary, are too few for the purpose of leading to any sound inference in a comparison of their results with those of the very large numbers comprehended in the later Tontines. But this is a great mistake. If the matter were so, the relations of the small to the great numbers would sometimes be one way, sometimes another; whereas they are uniformly in one direction. Their story, each sex speaking for itself, is never inconsistent nor contradictory of each other. Provided only, and *on the express condition* that the fact of age is scrupulously ascertained, there is nothing more wonderful to my apprehension than the regularity with which death exacts his impartial per centage, just alike from the small as from the large masses of the living: and truly said Horace 1900 years ago—"Pallida Mors æquo pulsat pede."

The Facts of which I have thus given you an outline were of course, with all the skill of which I am capable, expanded by me into the form of regular Tables, and as resulting from these I present you with the Expectation of Life in years and decimal fractions of a year—the English and Irish Tontines being all combined into one:—

THE FEMALE SEX.

Age.	*King William's Tontines.*	*Mr. Pitt's Tontines.*
90	2.500	2.860
85	2.879	4.117
80	4.312	5.606
75	6.073	7.701
70	8.322	10.123
65	11.058	12.885
60	13.698	16.040
55	16.133	19.440
50	18.574	22.858
45	21.228	26.265
40	23.997	29.733
35	26.672	33.185
30	29.301	36.520
25	31.927	39.951
20	34.591	43.145
15	37.599	46.389
10	41.092	50.186
4	44.389	53.627

THE MALE SEX.

Age.	*King William's Tontines.*	*Mr. Pitt's Tontines.*
90	2.500	2.860
85	3.281	3.773
80	4.255	5.177
75	5.713	6.757
70	7.521	8.796
65	9.536	11.451
60	12.152	14.335
55	14.961	17.380
50	16.813	20.117
45	19.575	24.073
40	21.9[illegible]	27.416
35	24.4[illegible]	30.645
30	2[illegible]	33.755
25	2[illegible]	36.534
20	29.4[illegible]	38.935
15	32.382	42.266
10	3[illegible]	46.208
4	40.268	49.739

I have now supplied you with all the information on this very interesting subject which falls within the province of an Actuary. The remaining part of the discussion devolves most properly on yourself as a Physician; and from grateful experience of your talents in my own case, during a period of more than twenty years, I am well aware that the matter cannot be in better hands.

With the highest regard I remain,

My Dear Sir,

Your sincere friend and servant,

JOHN FINLAYSON,

President of the Institute of Actuaries.

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